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NATIONAL DAM SAFETY PROGRAM. CRANBERRY LAKE DAM (NY00397), ST. --ETC(U)
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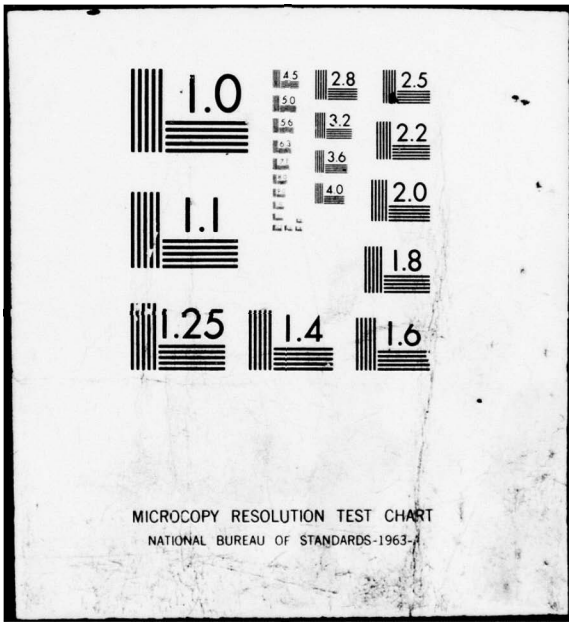
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ST. LAWRENCE RIVER BASIN

OSWEGACHIE RIVER, ST. LAWRENCE COUNTY

NEW YORK

CRANBERRY LAKE DAM

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

NY 00397

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10007

JULY 1978

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, NEW YORK
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10007

2 OCT 1978

NANEN-F

Honorable Hugh L. Carey
Governor of New York
Albany, New York 12224

Dear Governor Carey:

The purpose of this letter is to inform you of a clarification of the guidelines used by this office in assessing dams under the National Program of Inspection of Dams.

Office of the Chief of Engineers has recently provided a clarification that dams with seriously inadequate spillways are to be assessed as unsafe, non-emergency, until more detailed studies prove otherwise or corrective measures are completed.

The following dams in your state have previously been assessed as having seriously inadequate spillways, with capability to pass safely only the percentage of the probable maximum flood as noted in each report. They are now to be assessed as unsafe:

I.D. NO.	NAME OF DAM
N.Y. 59	Lower Warwick Reservoir Dam
N.Y. 4	Salisbury Mills Dam
N.Y. 45	Amawalk Dam
N.Y. 418	Jamesville Dam
N.Y. 685	Colliersville Dam
N.Y. 6	Delta Dam
N.Y. 421	Oneida City Dam
N.Y. 39	Croton Falls Dam
N.Y. 509	Chadwick Dam (Plattenkill)
N.Y. 66	Boyds Corner Dam
N.Y. 397	Cranberry Lake Dam
N.Y. 708	Seneca Falls Dam
N.Y. 332	Lake Sebago Dam
N.Y. 338	Indian Brook Dam
N.Y. 33	Lower(S) Wiccopee Dam (Lower Hudson W.S. for Peekskill)

NANEN-F
Honorable Hugh L. Carey

I.D. NO.	NAME OF DAM
N.Y. 49	Pocantico Dam
N.Y. 445	Attica Dam
N.Y. 658	Cork Center Dam
N.Y. 153	Jackson Creek Dam
N.Y. 172	Lake Algonquin Dam
N.Y. 318	Sixth Lake Dam
N.Y. 13	Butlet Storage Dam
N.Y. 90	Putnam Lake (Bog Brook Dam)
N.Y. 166	Pecks Lake Dam
N.Y. 674	Bradford Dam
N.Y. 75	Sturgeon Pool Dam
N.Y. 414	Skaneateles Dam
N.Y. 155	Indian Lake Dam
N.Y. 472	Newton Falls Dam
N.Y. 362	Buckhorn Lake Dam

The classification of "unsafe" applied to a dam because of a seriously inadequate spillway is not meant to connote the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean, however, that based on an initial screening, and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream from the dam.

Consequently, it is advisable to implement the recommendations previously furnished in the reports for the above-mentioned dams as soon as practicable.

It is requested that owners of these dams be furnished a copy of this letter and that copies be permanently appended to all reports previously furnished to you.

Sincerely yours,

CLARK H. BENN
Colonel, Corps of Engineers
District Engineer

ST. LAWRENCE RIVER BASIN

Name of Dam: Cranberry Lake Dam
County and State: St. Lawrence County, New York State
Inventory Number: NY 00397

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared by: O'Brien and Gere Engineers, Inc.

For: New York State
Department of Environmental Conservation

Date: July 12, 1978

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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7. AUTHOR(s) (10) John J. Williams, P.E.		8. CONTRACT OR GRANT NUMBER(s) (15) DACW51-78-C-0035
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(16) **National Dam Safety Program. Cranberry Lake Dam (NY#397), St. Lawrence River Basin, Oswegachie River, St. Lawrence County, New York. Phase I Inspection Report.**

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety
National Dam Safety Program
Visual Inspection
Hydrology, Structural Stability
St. Lawrence County
Cranberry Lake Dam
Oswegachie River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization.

Cranberry Lake Dam was judged unsafe, non-emergency due to a seriously inadequate spillway.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

PHASE I REPORT

NATIONAL DAM INSPECTION PROGRAM

Name of Dam: Cranberry Lake Dam

State Located: New York
County Located: St. Lawrence County
Stream: Oswegachie River
Date of Inspection: June 12, 1978

ASSESSMENT OF GENERAL CONDITIONS

Cranberry Lake Dam consists of a concrete gravity structure and a wide earthen embankment.

No serious structural deficiencies were noted during the visual inspection of the dam. However, seepage was observed on the downstream face of the spillway and in the toe area downstream of the left abutment. Settlement of backfill material along the training wall and a sinkhole-type depression were located in the embankment area.

Review of the stability analyses indicates that the structure is unstable for all loading conditions relative to sliding based on criteria established by the Department of the Army, Office of the Chief of Engineers. An investigation of the existing foundation would allow a more comprehensive evaluation of this condition.

Evaluation of the Hydraulics/Hydrologic analyses indicated that the spillway could pass approximately 18 per cent of the PMF without

overtopping of the non-overflow sections and earthen embankment. In accordance with Engineering Technical Letter No. 1110-2-234, the spillway capacity is considered seriously inadequate.

O'BRIEN & GERE, ENGINEERS, INC.

John J. Williams

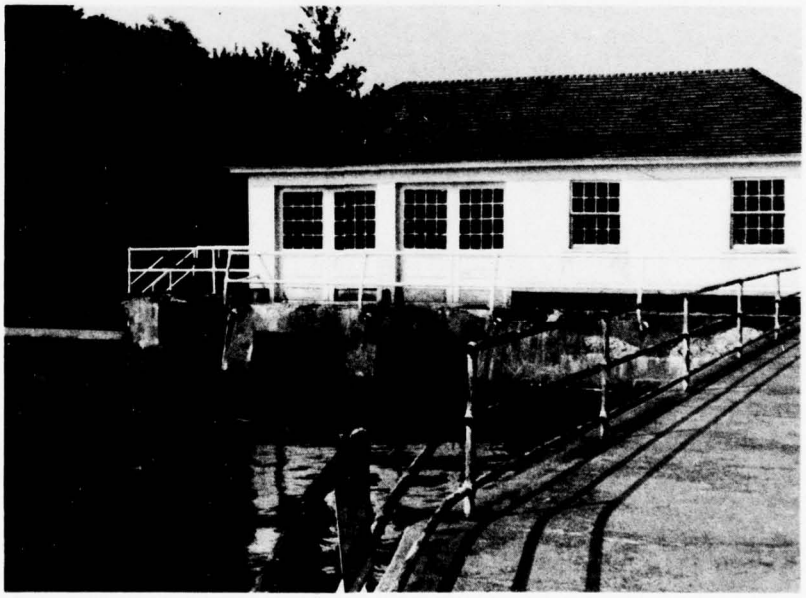
John J. Williams, P.E.
Vice President

Approved by: Clark H. Benn

Clark H. Benn
Colonel, Corps of Engineers
District Engineer

Date: 21 September 78

OVERALL VIEW OF DAM



GATE HOUSE

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM CRANBERRY LAKE DAM ID# NY 00397

SECTION I - PROJECT INFORMATION

1.1 GENERAL

a. Authority - This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with contract #1467-021 between O'Brien and Gere Engineers, Inc., and the New York State Department of Environmental Conservation.

b. Purpose of Inspection - The purpose of this inspection is to evaluate the structural and hydraulic conditions of Cranberry Lake Dam, and appurtenant structures, and to determine if the dam constitutes a hazard to human life or property.

1.2 PROJECT DESCRIPTION

a. General - Cranberry Lake Dam is located in St. Lawrence County on the Oswegachie River about ten miles east of Newton Falls, New York. The dam is owned and operated by the Oswegatchie River - Cranberry Reservoir Commission (OR-CRC) and is used to regulate river flows for water supply, power development and recreation.

According to drawings provided by the New York State Department of Environmental Conservation (NYSDEC), initial construction of the dam took place in 1917; the dam in its present configuration was completed in 1956.

The dam consists of a concrete gravity structure and a wide earthen embankment. The earthen embankment is located between the north abutment and the concrete gravity section. A training wall, forming the north bank of the approach channel, is constructed adjacent to the embankment and ties into the gravity structure at its north end. A gatehouse and sluiceway is situated on the dam at this location.

An ungated spillway, about 110 feet long, extends from the gatehouse and sluiceway section towards the south abutment. The spillway is terminated by a non-overflow section which continues to the south abutment and appears to be keyed into bedrock.

b. Size and Hazard Classification - (from drawings and information provided by NYSDEC and OR-CRC) The maximum height of the non-overflow section of the dam is approximately twenty-four (24) feet. The reservoir volume to the spillway crest is about 57,400 acre-feet. According to the Recommended Guidelines for Safety Inspection of Dams, the dam is in the large size category.

Cranbery Lake Dam is located upstream of residential dwellings and loss of life and damage to property could reasonably be expected if the dam were to fail. Therefore, the dam is in the high hazard category as defined by the Recommended Guidelines for Safety Inspection of Dams. The spillway design flood required for hydraulic analysis is the Probable Maximum Flood (PMF).

1.3 PERTINENT DATA (based on information and drawings provided by the NYSDEC and the OR-CRC)

a. Drainage Area - 144 square miles

b. Discharge at Damsite - Reservoir stage readings and discharge through the gated openings are recorded daily by the OR-CRC.

c. Elevations (above MSL)

Top of non-overflow section - 1493.5
Spillway Crest - 1490.0

d. Reservoir Data (at spillway crest elevation)

Storage - 57,400 acre-feet
Surface Area - 10.9 square miles

e. Dam Data

Concrete gravity section
Length - 210 ± feet
Height - 24 ± feet

Earth embankment
Length - 150± feet
Height - 24± feet
Top Width - 150 ± feet (maximum section)

f. Outlet Data

Gated Openings - Two 4' x 5' openings are located through the non-overflow structure at the base of the

gatehouse. The discharge invert is at elevation 1472.2. Both openings are fitted with manually operated sluice gates.

Sluiceways - Two sluiceways six feet wide and extending the full height of the dam are located adjacent to the gatehouse. The base elevation is at 1472.2. Both sluiceways are fitted with manually operated stoplog assemblies.

Ungated opening - An ungated opening is located immediately south of the gatehouse. The invert elevation is about 1490.0

Sluiceway - A 6 foot wide log sluice is located between the ungated opening and spillway. The log sluice is fitted with a manually operated stoplog assembly.

g. Spillway Data

Type - concrete weir
Length - 110 feet
Crest elevation - 1490.0
Downstream Channel - A concrete apron is constructed immediately below the spillway. The apron extends about 20 feet downstream.

h. Flood Elevation of the Dam (MSL feet) - The flood crest elevation was determined for the Probable Maximum Flood.

PMF Elevation - 1496.0

i. Engineering Data - The engineering data provided by NYSDEC and OR-CRC for review of Cranberry Reservoir Dam included:

Plan set (4 sheets) - Concrete Bulkhead and Dam at Cranberry Lake, dated August 14, 1916.

Plan set (10 sheets) - Oswegatchie River - Cranberry Reservoir Commission, dated April 20, 1956.

1.4 OPERATING AND MAINTENANCE PROCEDURES

a. Operation - The dam is used to regulate river flows for water supply, power development and recreation. The reservoir is maintained at maximum pool during the recreational season. New York State requires that the maximum pool does not exceed a depth

of 9 inches above the spillway crest (Elevation 1490.75). A minimum discharge of 720 cfs is also required by the State.

b. Maintenance of Dam and Operating Facilities - The dam and operating facilities are maintained on an "as required" basis. According to the owner's representative, the dam is formally inspected about once every three years.

c. Flood Warning System - According to the owner's representative, no flood warning system is in effect.

SECTION 2 - VISUAL INSPECTION

2.1 FINDINGS

a. General - The field inspection of Cranberry Lake Dam was conducted on June 12, 1978. At time of inspection, the water level was about one foot below the spillway crest. No underwater areas were inspected.

b. Earthen Embankment - A wide earthen embankment is located between the concrete gravity dam and the north abutment. A training wall, approximately 150 feet long, retains the embankment and forms the north bank of the approach channel. The training wall is tied into the gravity structure at the downstream end of the embankment.

Settlement in the material used to backfill the training wall was noted at several locations along the length of the wall. Indications of erosion were evident at the junction of the embankment with the concrete gravity structure.

The crest of the embankment is about 200 feet wide and is grass covered. A sinkhole-type depression was located in the embankment about 50 feet from the training wall and 100 feet from the upstream slope. The existance of a concrete cut-off wall (as shown on Figure 4) in the embankment could not be verified.

c. Gatehouse - The gatehouse is located on the north end of the concrete dam. Four openings, located in the non-overflow section below the gatehouse, are used for passing flows through the structure. Two of the openings are fitted with sluice gates; the remaining openings are fitted with stoplog assemblies. Although the stoplogs were in place during the inspection, significant leakage was observed through both stoplogs.

A sluiceway is positioned to the left of the gatehouse and is used for sluicing logs and debris. The stoplogs were in position and no leakage was observed.

All gates and stoplogs are manually operated. The gate and stoplog operating equipment appeared to be well maintained and in working condition.

Trash racks are located at the intakes to both gated openings; only minor indications of corrosion were noted on the structures. Some trash was accumulated on both racks.

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Settlement in the material used to backfill the training wall was noted at several locations along the length of the wall. Indications of erosion were evident at the junction of the embankment with the concrete gravity structure.

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Settlement in the material used to backfill the training wall was noted at several locations along the length of the wall. Indications of erosion were evident at the junction of the embankment with the concrete gravity structure.

The crest of the embankment is about 200 feet wide and is grass covered. A sinkhole-type depression was located in the embankment about 50 feet from the training wall and 100 feet from the upstream slope. The existance of a concrete cut-off wall (as shown on Figure 4) in the embankment could not be verified.

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Trash racks are located at the intakes to both gated openings; only minor indications of corrosion were noted on the structures. Some trash was accumulated on both racks.

The downstream face of the gatehouse and sluiceway is protected with a gunite surface treatment. The gunite surfacing has cracked over most of this area and spalled concrete was noted in a few of the areas where the gunite had scaled from the structure. Severe erosion of the gunite is evident at the base of the piers separating the individual gates and stoplog slots.

Immediately below the sluiceway, a large portion (approximately) 10 feet by 6 feet) of the gunite material has scaled and dislodged from the structure. The gunite thickness is about two inches. The anchors and wire mesh used to secure the gunite to the structure are exposed in this location.

The concrete on the upstream side of the gatehouse appears to be in good condition. Some spalling of concrete was observed above the intakes to the gatehouse. The spalling is localized; no exposed reinforcing steel was noted.

d. Spillway - The upstream slope of the spillway is severely spalled below the water line. Large cracks are apparent thoughout the portion of the slope which is visible. The concrete spillway crest shows no significant deterioration. There were no noticeable deviations in the crest alignment.

Seepage was observed on the downstream face of the spillway section occurring at a rate sufficient to keep the concrete surface moist. Sounding of the concrete surface revealed areas of "soft" and "drummy" or deteriorated concrete.

A concrete slab is located at the base of the spillway and extends downstream for about twenty feet. The joint between the slab and toe of the gravity section is open and filled with water. Reinforcing steel extending from both the slab and gravity section is exposed along this joint. Probing of the joint indicated a void area extending at least three feet into the gravity section. A bubbling action was noted at one place along this joint.

e. Non-Overflow Section - The spillway section terminates in a non-overflow section which extends about thirty feet to the south abutment. The concrete is spalled and reinforcing steel is exposed in the non-overflow section above the junction with the spillway. The non-overflow section appears to be keyed into a rock foundation.

Seepage was observed at the toe of the non-overflow section about 35 feet from the south abutment and at the toe of the overburden downstream of the south abutment. The seepage rates were estimated to be about 1 gpm. Approximately 100 feet downstream of the left abutment, pools of rusty colored water were located above the channel bank. No movement was observed in the pools.

f. Approach Channel - The approach channel to the dam is about 150 feet long. The north bank is protected by a training wall. The south side of the approach channel is unprotected and comprises natural slopes. No indications of slope instability were observed in this area.

g. Downstream Channel - The channel bottom downstream of the gatehouse is protected with rock set in place; the channel immediately below the spillway is protected by a concrete apron. No indications of erosion were observed at either location although the surface of the concrete slab is noticeably pitted and spalled.

The south bank of the channel is unprotected and comprises natural slopes. No erosion or slope instability was observed along this bank. The north bank is protected by riprap supported by steel rails and cribbing for about 100 feet below the gatehouse. Some erosion or slumping of bank and fill, in and behind the cribbing, was noted. A highway bridge is located about 300 feet downstream from the dam.

SECTION 3 - HYDROLOGY AND HYDRAULICS

In accordance with the criteria published in the Recommended Guidelines for Safety Inspection of Dams, the Spillway Design Flood required for evaluation of the hydraulic capabilities of Cranberry Lake Dam is the Probable Maximum Flood (PMF). The PMF was calculated from probable maximum precipitation data published in Hydrometeorological Report No. 33.

Rainfall data was modified to account for basin size and storm characteristics by using standard reduction factors. The HEC-I computer program was used to develop the inflow hydrograph and flood route the PMF through the reservoir facility.

Peak inflow and outflow rates for the PMF were calculated to be 79,000 cfs and 16,800 cfs respectively. The PMF would increase the water surface to Elevation 1498.9, overtopping the spillway by 8.9 feet, and overtopping the non-overflow sections and training wall by 5.4 feet. Peak inflow and outflow rates for one-half of the PMF were calculated as 39,500 cfs and 6,400 cfs respectively. The dam could pass about 18 per cent of the PMF without overtopping the non-overflow sections and embankment. The spillway is "seriously inadequate" as cited in ETL 1110-2-234.

A drawdown analysis was performed to estimate the time required to drain the reservoir. The starting water surface elevation was assumed at the spillway crest and inflow to the reservoir was considered negligible. The two gates were also assumed to be completely open. Under these conditions, the estimated time to drain the reservoir is about fifty-three days. A shorter time could be attained by using the available sluiceways; however, downstream constraints such as safe velocities and flows must be considered before establishing any minimum time for the drawdown procedure.

SECTION 4 - STRUCTURAL STABILITY

4.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observationss - No indications of structural instability were noted during the visual inspection of Cranberry Lake Dam.

b. Drawings - Design data and construction history relative to Cranberry Lake Dam were provided by NYSDEC and OR-CRC. The drawings consisted of two sets of design plans: original construction in 1917 and the major modifications made in 1956.

The more recent drawings (1956) do not confirm the construction of a key in the concrete gravity dam foundation. Also, a discrepancy was noted between the plans and actual conditions observed during the visual inspection relative to the downstream slope of the spillway section.

c. Operating Records - Reservoir stage readings and discharge through the gated openings are recorded daily by the OR-CRC. According to the owner's representative, ice thickness up to 40 inches in depth form on the reservoir surface.

d. Post Construction Changes - According to design drawings and data provided by NYSDEC, the original structure, constructed in 1917, was an Ambursen type dam. The structure was reconstructed as a gravity dam and the spillway raised to its present elevation in 1956. A gunite surface treatment was applied to the gatehouse and spillway in 1957.

e. Seismic Stability - According to the Geologic Map of New York (Adirondack sheet) dated 1970, Cranberry Lake Dam is founded on primarily granular, and bouldery glacial and alluvial deposits, the thickness of which cannot be ascertained from supplied design or construction drawings. The geologic map indicates the occurrence of gneissic bedrock in the vicinity of the left abutment. Rock outcroppings were observed at this location during the visual inspection.

Cranberry Lake Dam is situated in Zone 3 as shown on the Seismic Zone Map of Contiguous States and, therefore, could be subjected to major seismic activity. In view of this probability, the stability analyses considered the effect of seismic loading using the recommended coefficient for Zone 3 (a = 0.1 g).

Detailed information pertaining to foundation investigations is not available. Therefore, design assumptions concerning foundation characteristics were based on information obtained from general geologic maps and field observations made during the course of the inspection.

f. Evaluation - Four loading conditions were analyzed in evaluating the structural stability of the spillway. The results of these analyses are summarized in the appendix. The safety factors developed for sliding stability do not meet the criteria presented in the Recommended Guidelines for Safety Inspection of Dams (..."computed sliding safety factors approximating 3 or more for all loading conditions without earthquake, and 1.5 including earthquake, should indicate satisfactory stability, depending upon the reliability of the strength parameters used in the analyses"). The reported foundation conditions indicate that the structure is not constructed on bedrock; therefore, shear strength was not included in the analysis of sliding stability.

Furthermore, the resultant of forces for the spillway section is located outside the middle third of the base width for the PMF and ice loading conditions.

STABILITY ANALYSES
SUMMARY OF RESULTS

Loading Condition	Factor of Safety		Bearing Pressure	
	Overturning	Sliding	Toe	Heel
Normal Pool	2.05	1.84	17.8	1.4
PMF	1.41	1.15	16.0	-.3
Ice Load	1.35	1.04	27.2	-8.8
Earthquake	1.86	1.29	19.8	-.6

SECTION 5 - ASSESSMENT/RECOMMENDATIONS/REMEDIAL MEASURES

5.1 ASSESSMENT

In accordance with Recommended Guidelines for Safety Inspection of Dams the concrete gravity spillway is structurally unstable relative to sliding for all loading conditions. Furthermore, the resultant falls outside the middle third of the base width for the PMF and ice loadings conditions.

The upstream slope of the spillway is significantly cracked and spalled. However, no indication of relative movement in the structure was evident. Separation of the concrete has occurred at the junction of the toe of the spillway with the downstream slab. A void area extends at least 3 feet into the spillway section.

Seepage was observed on the downstream face of the spillway and in the toe and overburden areas downstream of the non-overflow section. Small pools of discolored water were also located on the channel bank about 100 feet downstream of the south abutment.

Settlement and erosion in the backfill adjacent to the training wall and a sinkhole type depression in the embankment area behind the training wall were noted. These conditions have not been investigated.

The spillway is hydraulically incapable of passing the PMF without overtopping the non-overflow sections. The spillway is capable of passing 18 per cent of the PMF without overtopping the non-overflow sections.

The gunite surface treatment is significantly cracked and has separated from the structure in a number of places. This condition does not appear to have a detrimental effect on the stability of the structure.

5.2 RECOMMENDATIONS/REMEDIAL MEASURES

Additional investigations, remedial measures and recommended actions are as follows:

1. A boring program should be performed to:

    a) Determine as built conditions.

b) Establish observation wells to monitor groundwater movement in the earthen embankment and north abutment.

c) Establish the existence of a keyway in the dam.

2. Further stability analysis should be performed based on the results of the boring program.

3. Develop an emergency drawdown procedure that could be accomplished in a minimum time taking into consideration all constraints relating to allowable downstream flows and velocities. This would include a flood warning system.

FIGURES

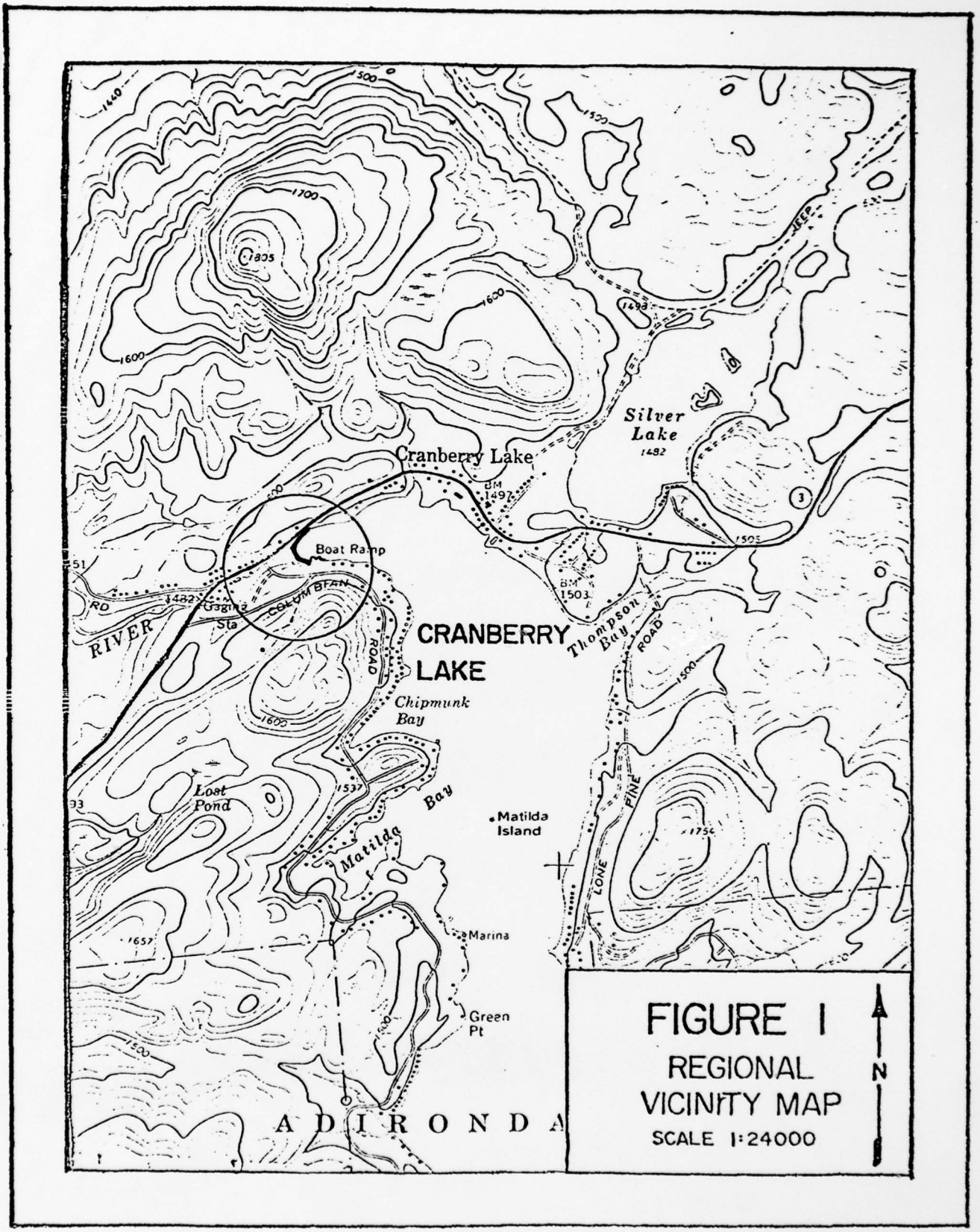
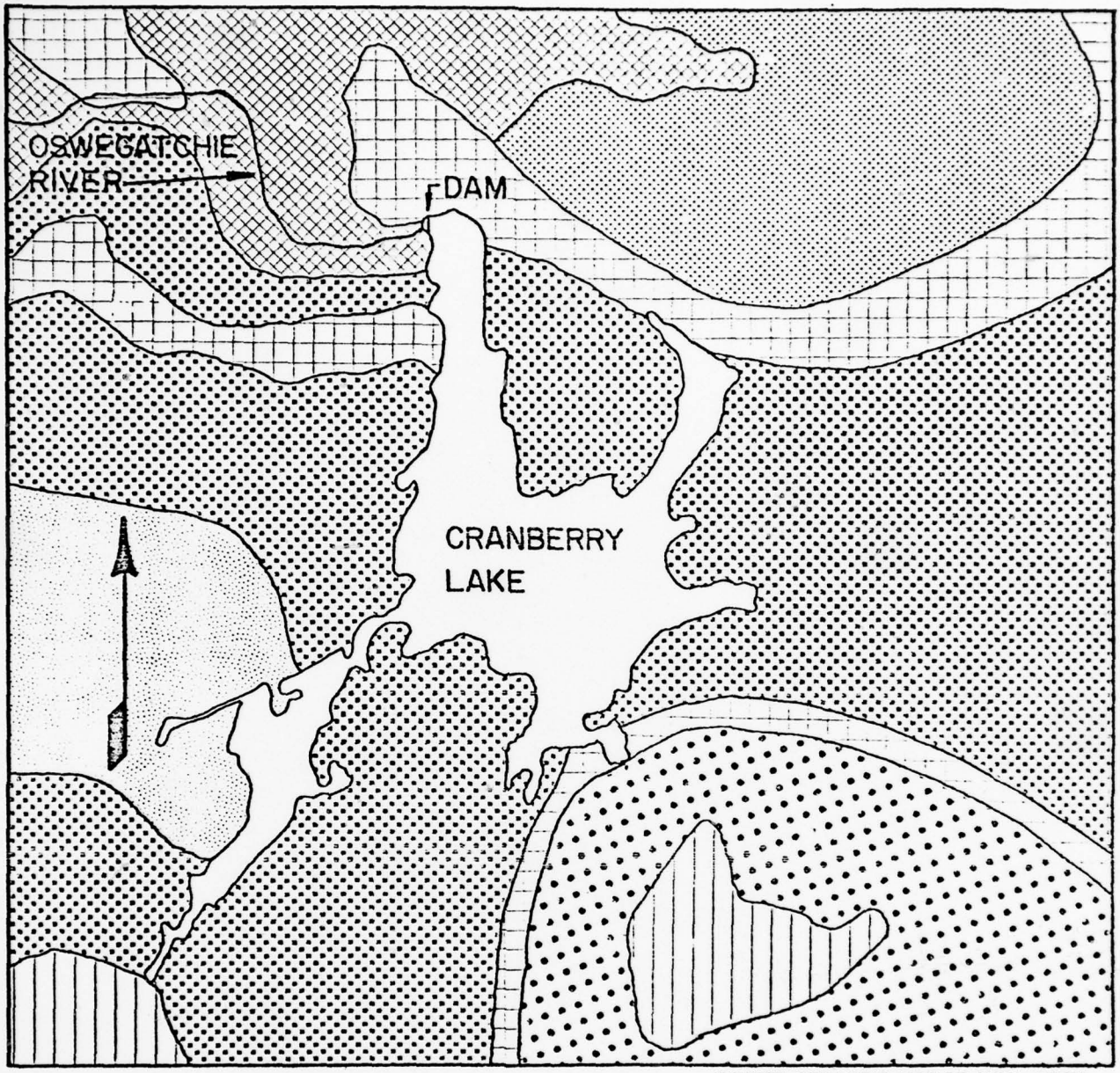


FIGURE 1
REGIONAL VICINITY MAP
SCALE 1:24000
N



SOURCE: GEOLOGIC MAP OF NEW YORK
ADIRONDACK SHEET 1970

LEGEND

amg · HORNBLENDE AND QUARTZ GNEISS

hbg · BLACK MICA AND/OR GRANITE

hqs · QUARTZ SYENITIC GNEISS

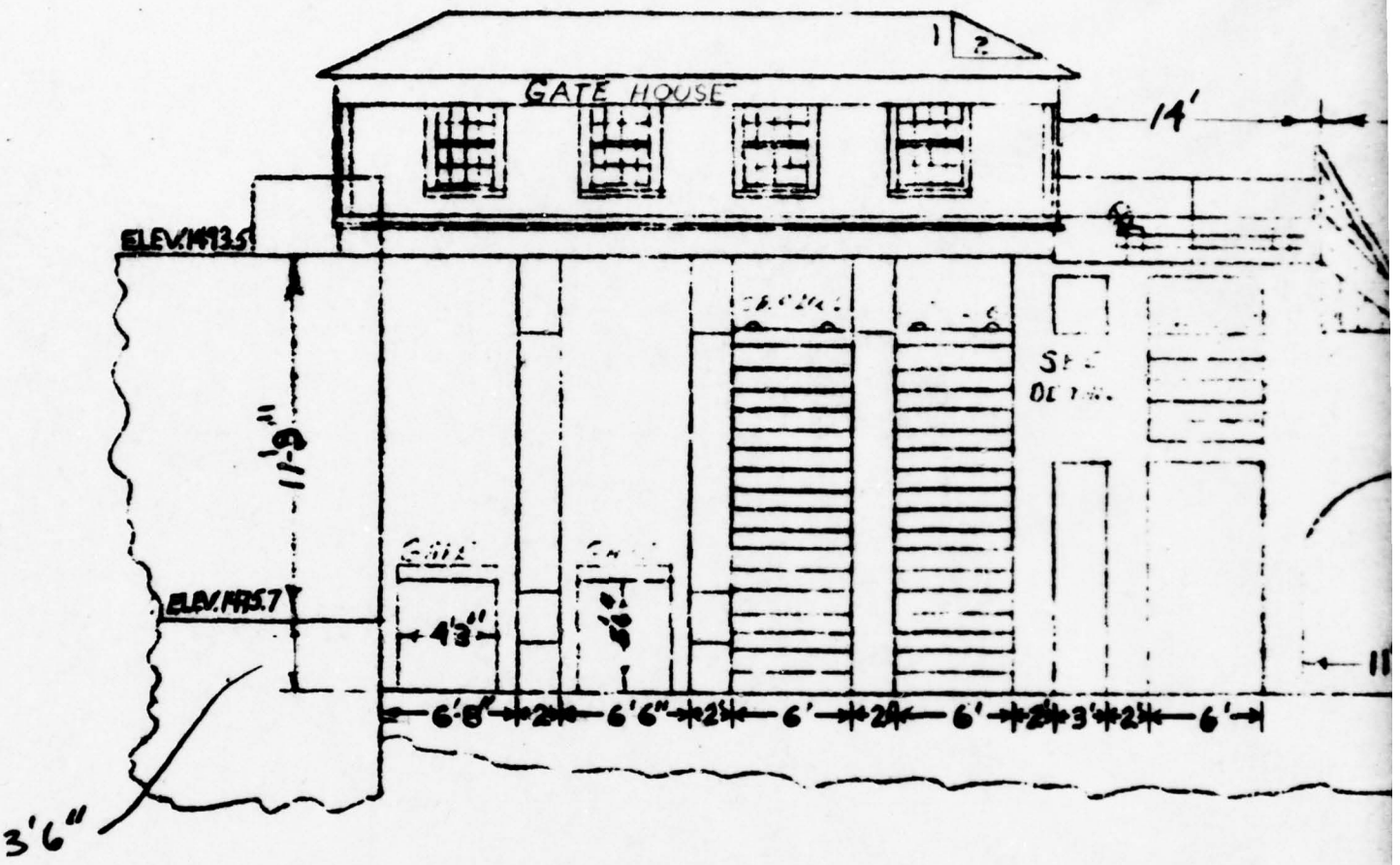
lg · LEUCOGRANTIC GNEISS

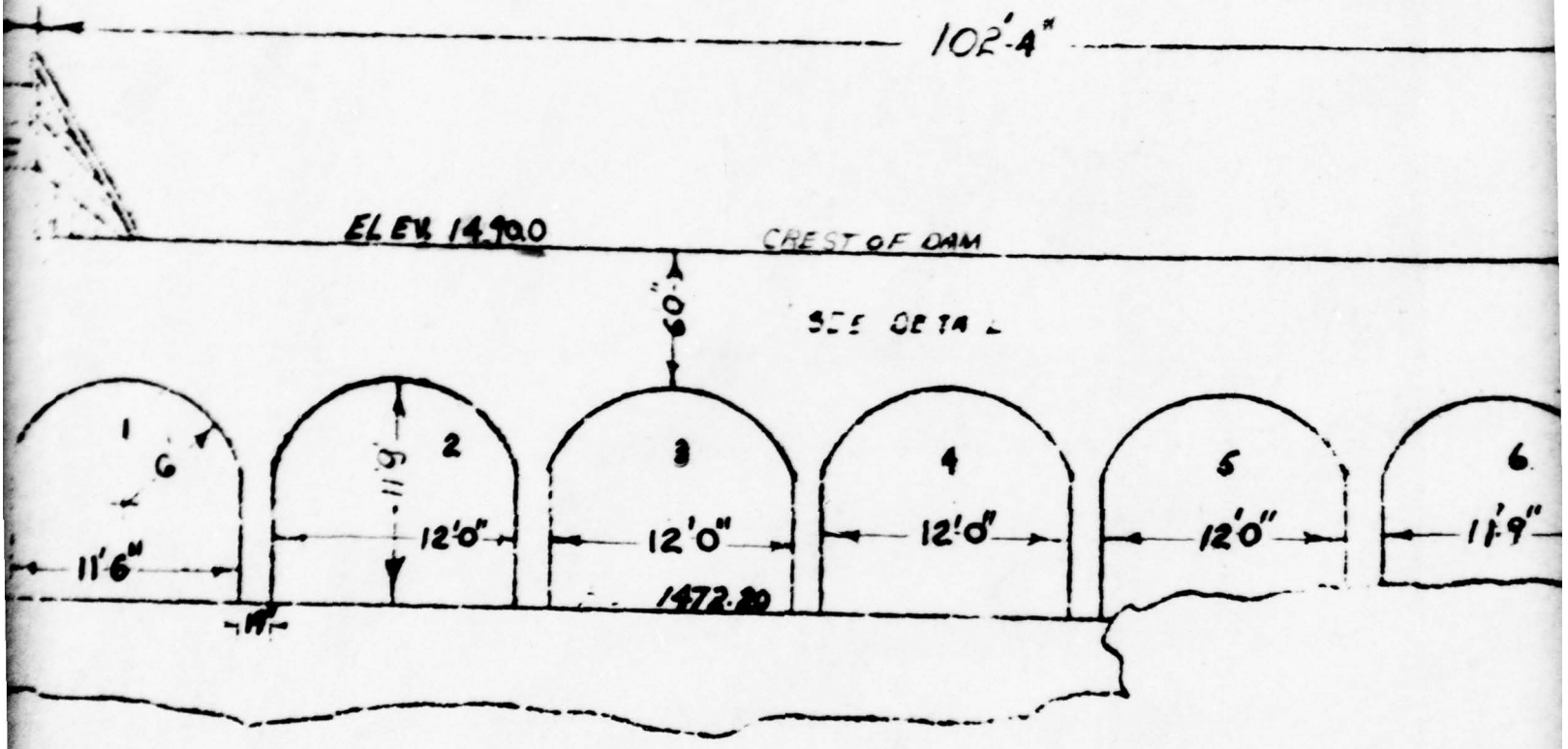
mu · FRAGMENTED METAMORPHIC ROCK

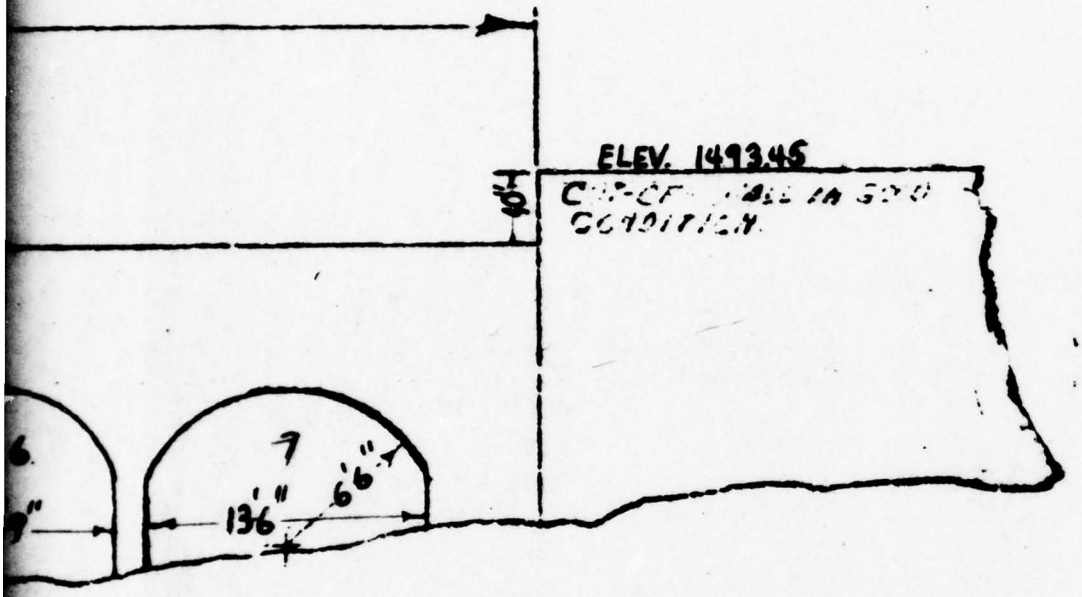
mug · FRAGMENTED GRANITIC GNEISS

Q · GLACIAL AND ALLUVIAL DEPOSITS

FIGURE 2
GEOLOGIC MAP

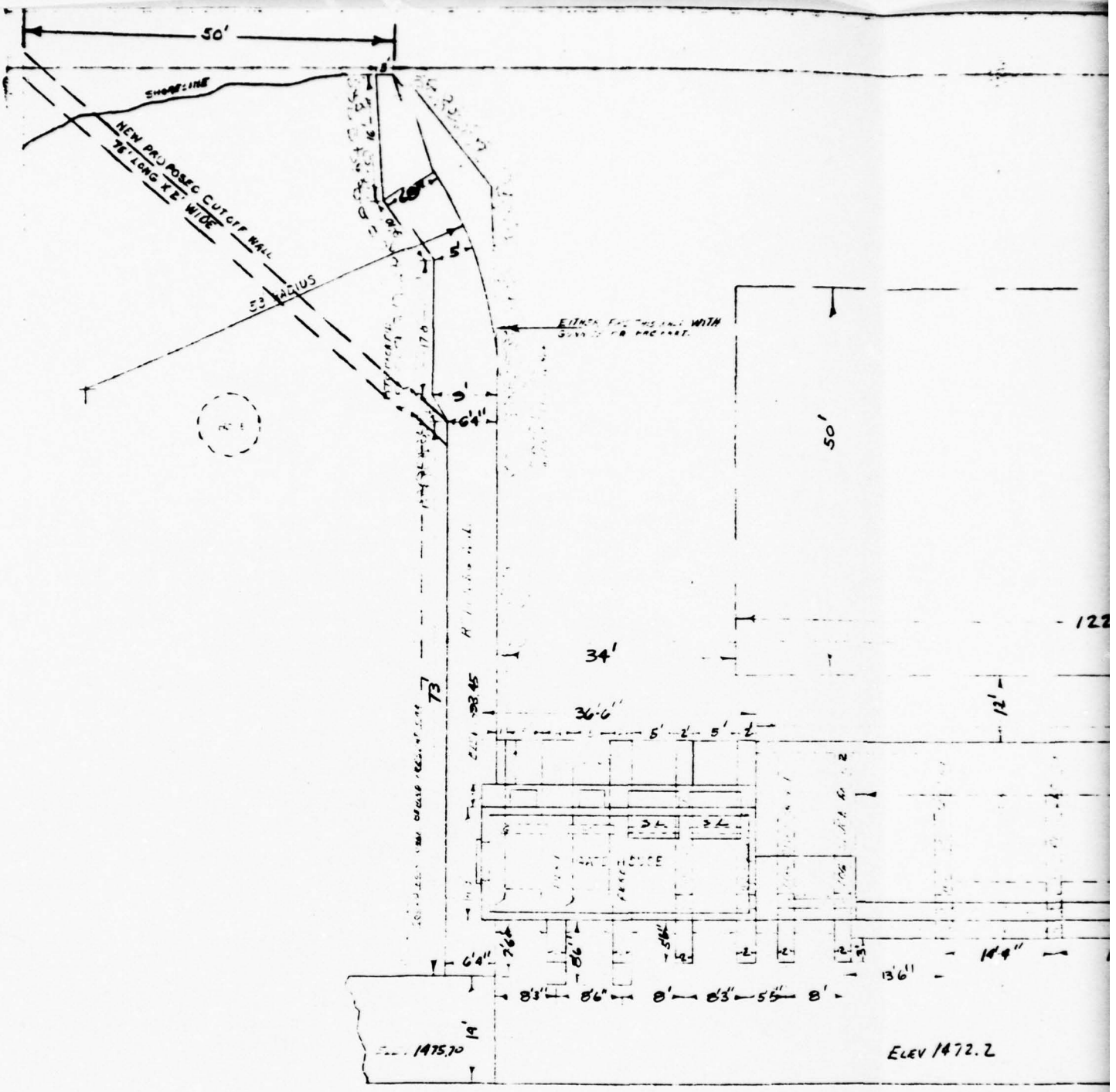

GATE HOUSE
14'
ELEV. 1493.5
11'-9"
ELEV. 1485.7
4'3"
6'8"
2½
6'6"
2½
6'
2½
6'
2½
3'
2½
6'
3'6"


102'-4"
ELEV. 1490.0
CREST OF DAM
SEE DETAIL
1
2
3
4
5
6
11'6"
12'0"
12'0"
12'0"
12'0"
11'9"
1472.80



CHESAPEAKE RIVER - CRANBERRY RESERVOIR COMMISSION	
AE Boyd - W.J. Mc... Jr. - AC Smith - Commissioners	
CRANBERRY RESERVOIR DAM CRANBERRY LAKE, N.Y. VIEW TOWARDS LE	
DATE: 4-18-56	DWG. 42-191
SCALE: 1/8" = 1'-0"	Drawn By: J.E. McM.
T By: J.E. Mc...	C... Smith - Engr.

FIGURE 3


50'
SHORELINE
NEW PROPOSED CUTOFF WALL
75' LONG X 2' WIDE
EXISTING
5'
3'
6'4"
50'
34'
36'6"
5'
2'
5'
2'
12'
73'
38.45
GATE HOUSE
6'4"
7'6"
8'6"
5'6"
3'
14'4"
13'6"
8'3"
8'6"
8'
8'3"
5'5"
8'
19'
1475.70
ELEV 1472.2

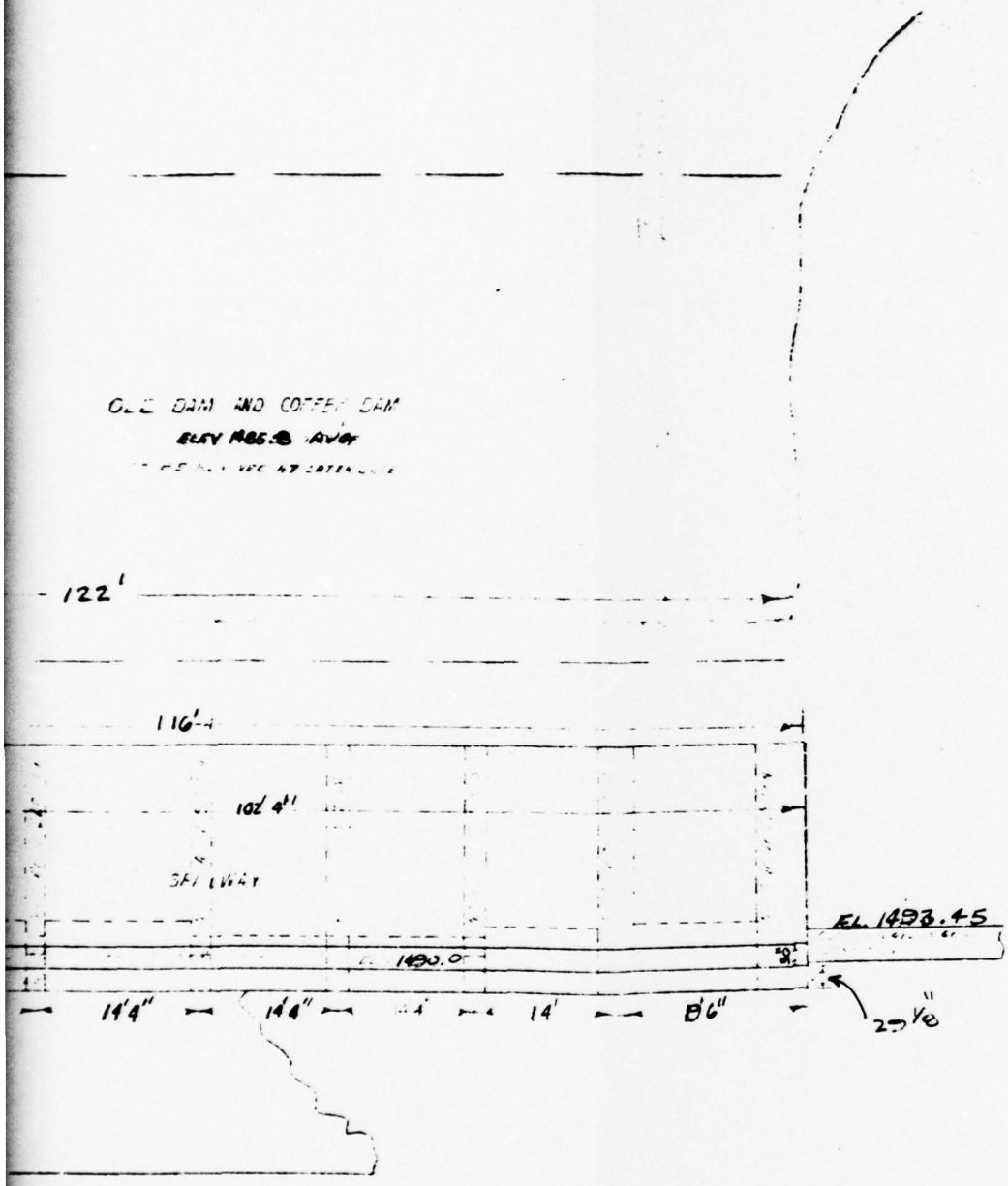
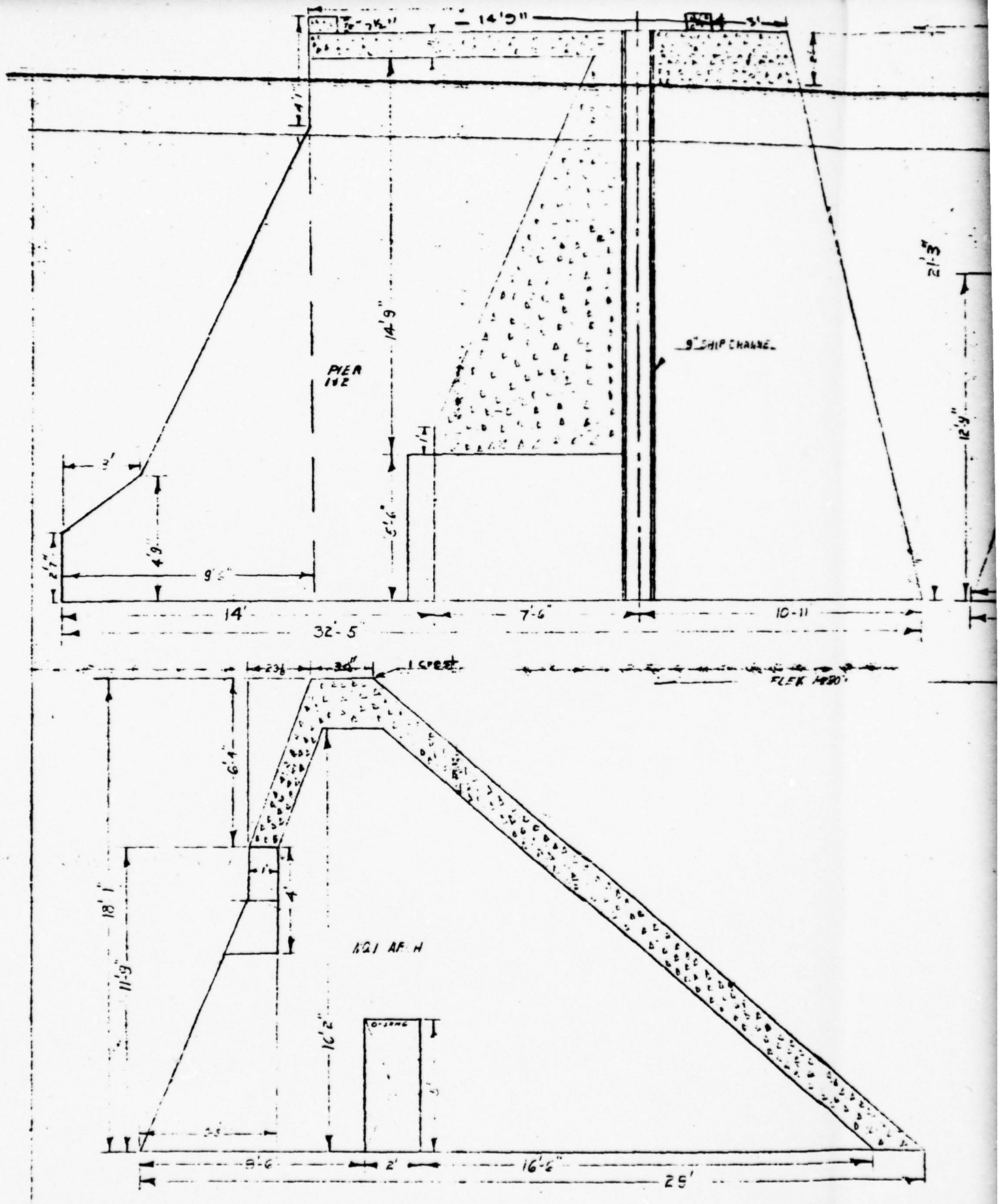
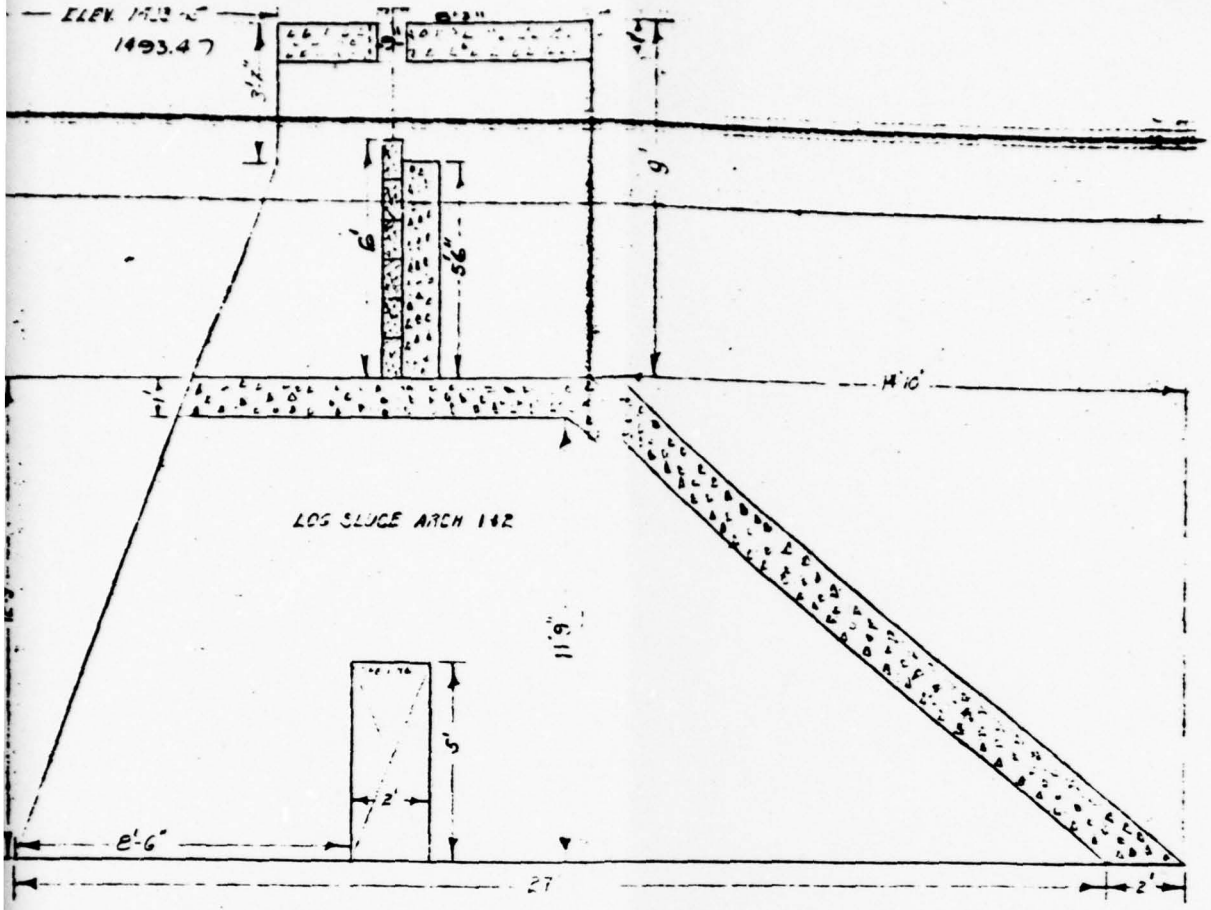


FIGURE 4


14'9"
PIER 142
14'9"
9" SHIP CHANNEL
21'3"
12'9"
3'
4'9"
2'1"
9'6"
5'6"
14'
7'-6"
10-11
32'-5
2 3/8
30"
1 crest
6'4"
18'1"
11'9"
4'
1'
16'2"
2'
9'-6
2'
16'-6"
25'


ELEV. 1493.47
6'
56"
9'
11'-9"
5'
2'
6'-6"
27'
2'
LOG SLUICE ARCH 1&2

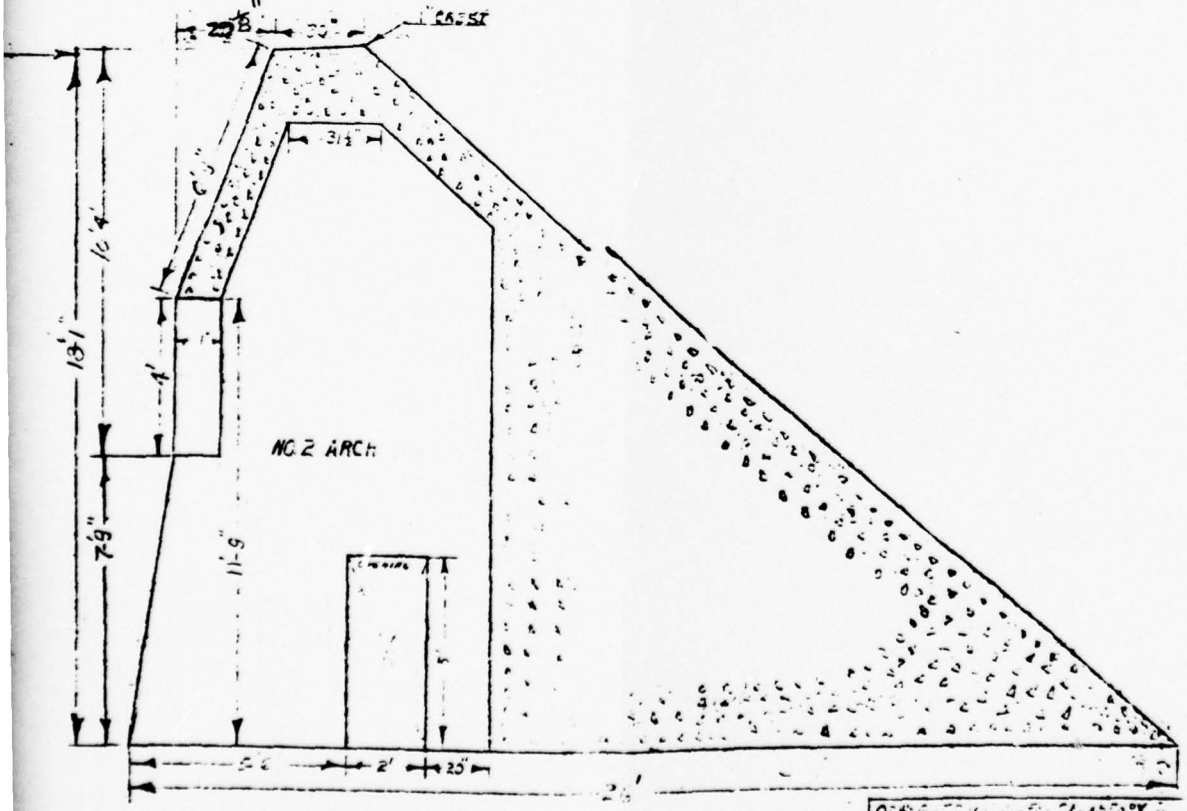

2'-8"
3'-0"
CREST
3½'
6'
13'-1"
16'-4"
4'
7'-9"
11'-9"
NO. 2 ARCH
5'-6"
2'
2'-5"
25'

FIGURE 5

2

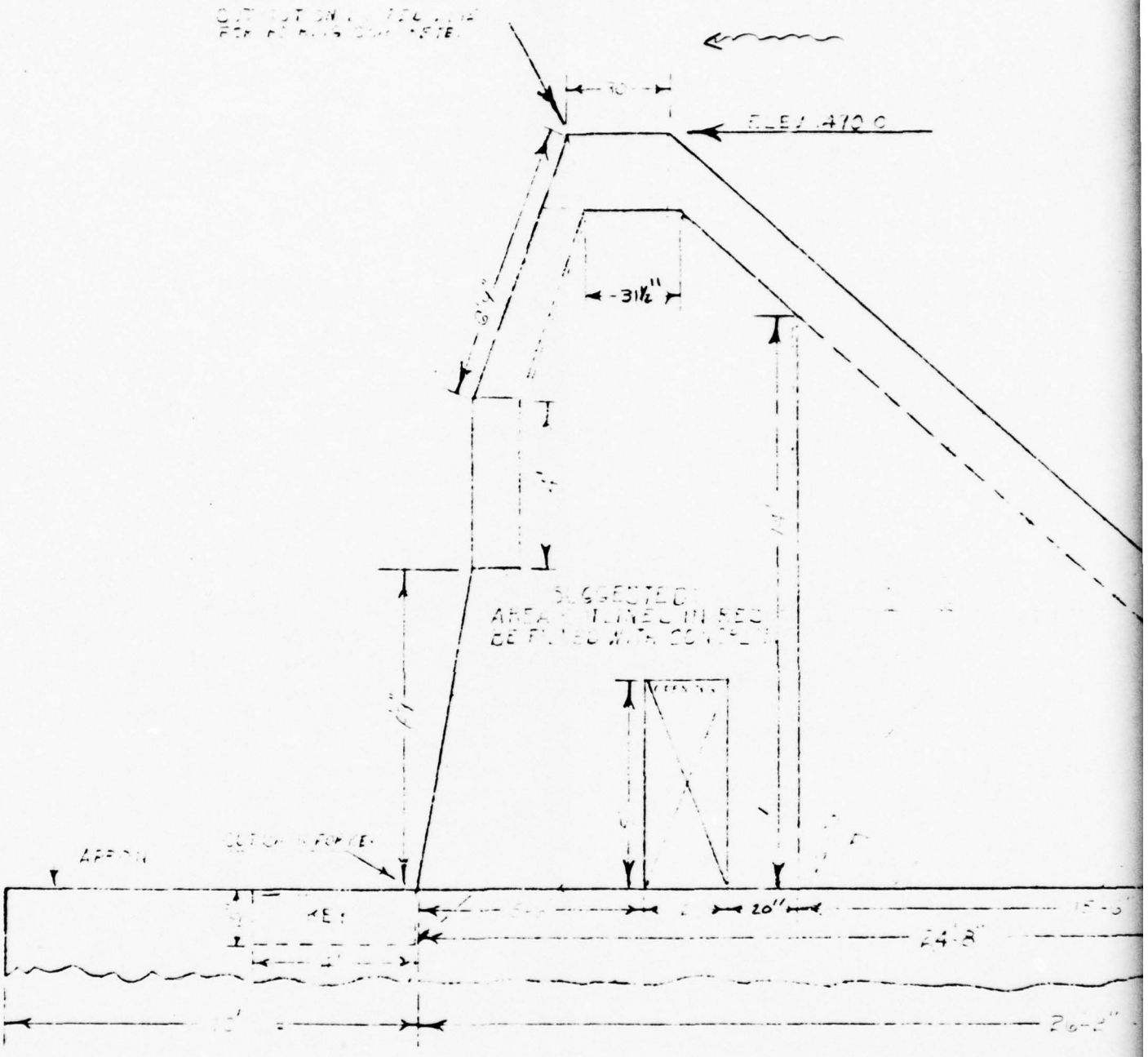
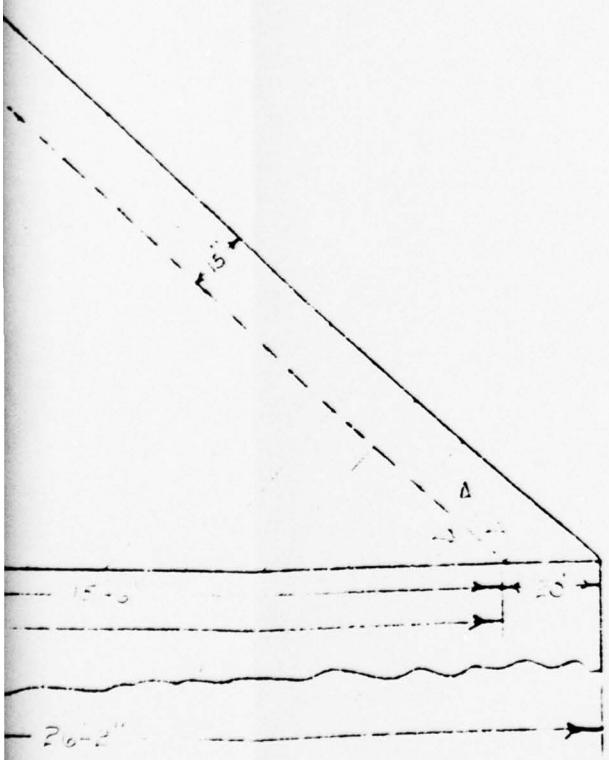


FIGURE 6



NEW PROPOSED SPILL

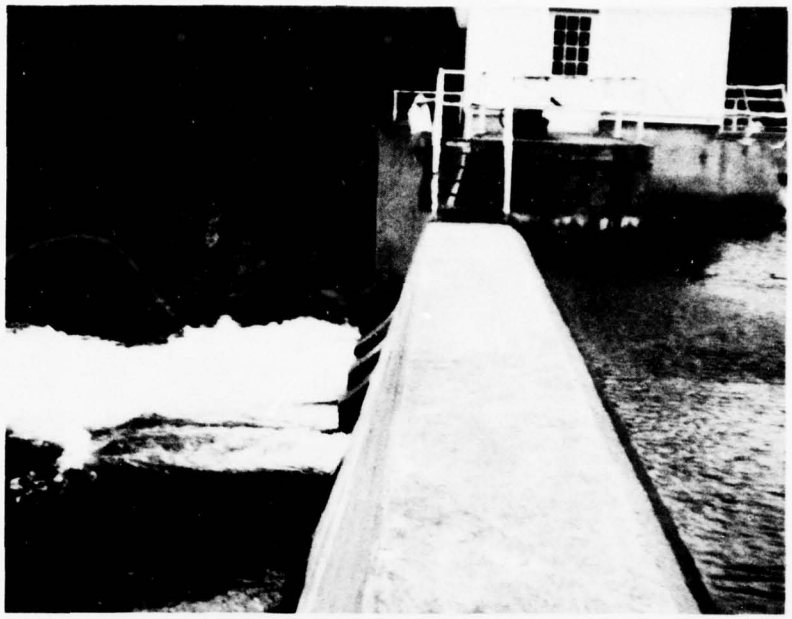
DATE	DWG. NO. 102
SCALE	
DRWN. BY	

URE 6

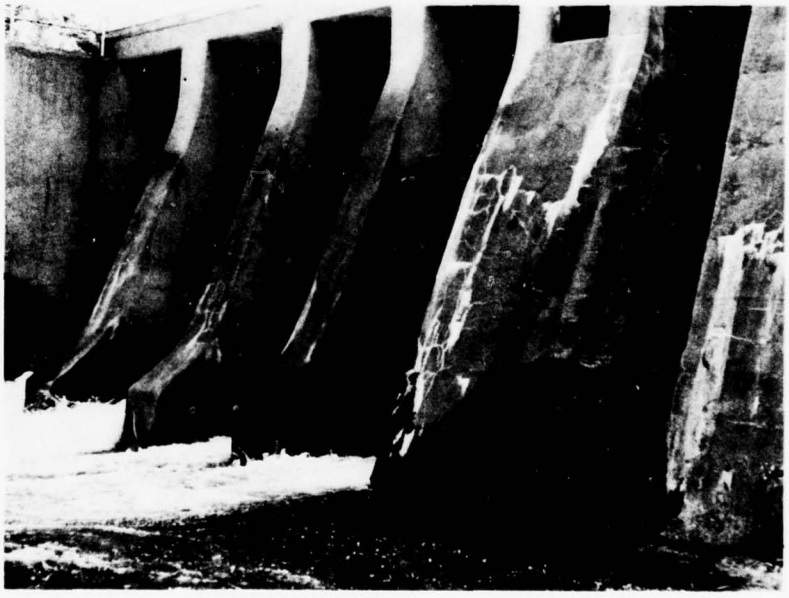
2

APPENDIX

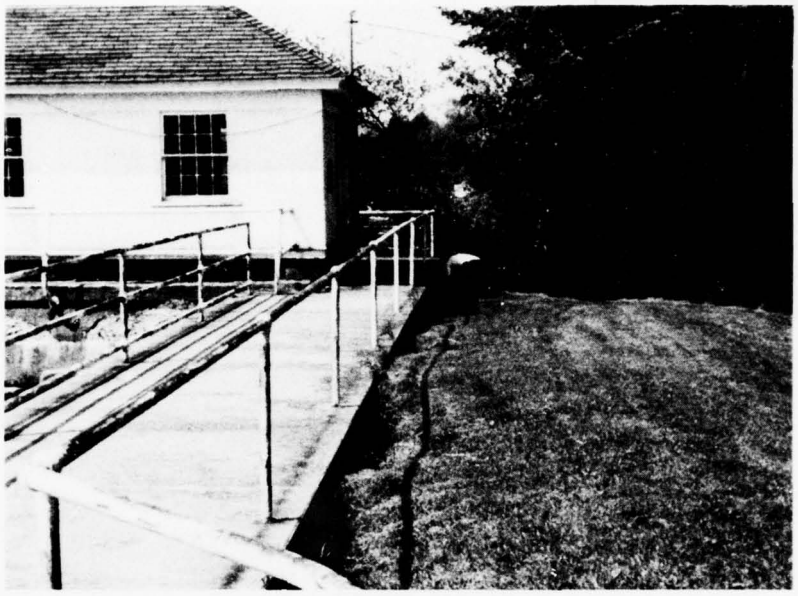
PHOTOGRAPHS



SPILLWAY CREST



GATE HOUSE PIERS



SETTLEMENT ALONG TRAINING WALL

DOWNSTREAM CHANNEL

FIELD INSPECTION REPORT

Check List
Visual Inspection
Phase 1

Name Dam Cranberry Lake Dam County St. Lawrence State New York Coordinators Mr. Maynard Miller OR-CRC

Date(s) Inspection June 12, 1978 Weather Sunny Temperature 70°F

Pool Elevation at Time of Inspection 1489 ± M.S.L. Tailwater at Time of Inspection N/A M.S.L.

Inspection Personnel:

Mr. J. J. Williams
Mr. J. V. Ryan
Mr. A. J. Depman
Mr. R. E. Horvath

Mr. R. E. Horvath Recorder

Accompanied by: Mr. Maynard Miller, Chairman, Oswegachie River-Cranberry Reservoir Commission

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SEEPAGE OR LEAKAGE		
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Settlement was observed in the backfill along the approach channel training wall and at the structure/embankment junction hole. A sink type depression was located in the embankment behind the training wall. Seepage was observed in the toe of the left abutment.	
DRAINS	No drains were noted.	
WATER PASSAGES	The gate controlled openings and sluiceway passages could not be inspected because of discharge. Minor cracking and spalling of the surface material in the log sluice and ungated opening were evident.	
FOUNDATION	Not observed.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
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FOUNDATION	Not observed.	

CONCRETE/MASONRY DAMS

SUAL EXAMINATION OF	OBERSVATIONS	REMARKS OR RECOMMENDATIONS
RFACE CRACKS NCRETE SURFACES	The upstream slope of the spillway is severely cracked and spalled. The severity of the cracking could not be determined. Some seepage was observed on the downstream face of the spillway.	
RUCTURAL CRACKING	See above.	
RTICAL AND HORIZONTAL IGNMENT	No significant deviations in the crest alignment of the spillway were evident. A slight but noticeable deviation in the horizontal alignment of the gatehouse piers was evident.	
NOLITH JOINTS		
NSTRUCTION JOINTS		

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None noted.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None noted.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Erosion was observed on the downstream slope of the embankment at the junction with the concrete gravity dam. No seepage was noted.	
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	N/A	
RIPRAP FAILURES	N/A	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	The gunite surface treatment on the piers separating the discharge channels is cracked and has eroded along the base of the openings.	
INTAKE STRUCTURE	The concrete surface above the intakes is spalled. Minor corrosion was noted on the trash rack structure.	
OUTLET STRUCTURE	N/A	
OUTLET CHANNEL The water passages discharge to the river. No erosion was evident.	N/A	
EMERGENCY GATE	N/A	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	The concrete weir appears to be in good condition. No spalling or cracking was noted.	
APPROACH CHANNEL	The concrete approach slab is severely cracked and spalled. The extent and severity of the cracking could not be determined.	
DISCHARGE CHANNEL	The spillway discharges to a concrete apron. The apron has separated from the spillway section and the surface is noticeably spalled and pitted.	
BRIDGE AND PIERS	N/A	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None noted.	
OBSERVATION WELLS	None noted.	
WEIRS	None noted.	
PIEZOMETERS	None noted.	
OTHER Staff Gage	A reservoir staff gage is located in the approach channel. According to the owner's representative, the gage reading is monitored and recorded daily.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	No indication of slope instability or erosion were noted in the areas observed.	
SEDIMENTATION	The degree of sedimentation could not be determined.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	A highway bridge is located about 300 feet downstream of the dam.	
SLOPES	The slope on the right bank is protected with retained riprap for a distance of about 100 feet downstream of the dam. The remainder of the distance down to the highway bridge is protected with riprap. Some minor settlement of the riprap was noted on the right bank. The left bank is unimproved and comprises natural slopes. No indications of slope instability were noted.	
APPROXIMATE NO. OF HOMES AND POPULATION	The area downstream of the dam is sparsely populated. However, the majority of the dwellings appear to be located adjacent to the riverbank.	

ITEM	REMARKS
MONITORING SYSTEMS	- A reservoir staff gage is located in approach channel.
MODIFICATIONS	- The originally constructed spillway (ambursen type) was modified to a gravity structure in 1956. The spillway crest was also raised to its present elevation in 1956.
HIGH POOL RECORDS	- Reservoir staff readings are recorded daily.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	- None were made available.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	- None were made available.
MAINTENANCE OPERATION RECORDS	- None were made available. According to the owner's representative, maintenance is performed on an as-required basis.

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	- Design drawings of the original construction (1917) and of the modifications (1956) were provided by NYSDEC and OR-CRC.
REGIONAL VICINITY MAP	- Not made available.
CONSTRUCTION HISTORY	- A verbal description of the construction history was provided by the owner's representative.
TYPICAL SECTIONS OF DAM	- Typical sections of the dam were included in the design drawings provided by NYSDEC and OR-CRC.
HYDROLOGIC/HYDRAULIC DATA	- Limited Hydrologic/Hydraulic data were made available.
OUTLETS - PLAN - DETAILS -CONSTRAINTS -DISCHARGE RATINGS	
RAINFALL/RESERVOIR RECORDS	- Not made available.

HYDROLOGIC AND HYDRAULIC CALCULATIONS

JUSTIN & COURTNEY, INC.
Division of O'Brien & Gere Engineers, Inc.
PHILADELPHIA, PA

SHEET NO. 1 OF

NAME OF CLIENT U.S. CORPS OF ENGINEERS

DATE 5/31/78

PROJECT CROOKED LAKE

COMP. BY DCC

CHECKED BY REH

DRAINAGE AREA (REMAINING) = 144 SQ. MILES

L = 26 MILES Lca = 8 MILES

AVERAGE [illegible]

C_T = .625 C_t = 2.0

$t_T = C_t (L \times L_{ca})^{.3} = 2.0(26 \times 8)^{.3} = 9.9$

$t_r = t_p / 5.5 = 1.8$ HOURS t_R = 2.0 HRS

$t_{pR} = t_p + .25(t_R - t_r) = 9.9 + .25(2 - 1.8) = 10.0$

---

6 HR PMP = 21"

REDUCTION DUE TO HOMBLE IMPERFECT FIT OF BASIN WITH STORM TO MAXIMIZE AT 12%

6 HR. PMP = 18.5"

DEPTH-AREA-DURATION FOR PMP

6 HR. PMP = 18.5" x .72 = 13.3"

12 HR. PMP = 18.5 x .85 = 15.7" 15.7 - 13.3 = 2.4"

JUSTIN & COURTNEY, INC.
Division of O'Brien & Gere Engineers, Inc.
PHILADELPHIA, PA

SHEET NO. 2 OF _____
DATE 6/1/78
COMP. BY DEC
CHECKED BY REH

NAME OF CLIENT CORPS OF ENGINEERS
PROJECT [illegible] LAKE

PMP DISTRIBUTION

TIME (HR)	RAINFALL	
0-2	8.6"	(6SD 6HR. PMP)
2-4	2.7"	(20% 6HR. PMP)
4-6	2.0"	(15% 6HR. PMP)
6-8	.8"	12 HR. PMP - 6HR. PMP
8-10	.8"	
10-12	.8"	

TIME RUNOFF DISTRIBUTION

TIME (HR)	RAINFALL
0-2	.8"
2-4	.8"
4-6	2.0"
6-8	8.6"
8-10	2.7"
10-12	.8"

O'BRIEN&GERE ENGINEERS

SUBJECT	SHEET	BY	DATE	JOB NO
CRANBERRY LAKE DAM	4	REL	6/20/78	

Checked DBC

STAGE - DISCHARGE

- ASSUME SLUICE GATES open (fully)

SLUICE GATES (2) - INV ELEVATION - 1472.2

- GATE SIZE - WIDTH = 5'

HEIGHT = 4'

ASSUME OUTLET CONTROL - W.S.E @ 1478 (avg for PMF condition)

uniform passage through gate house

Head losses - ENTRANCE LOSS = .5

RACK LOSS = .15

$n = .012$

$L \approx 15'$

$r = \frac{20}{18} = 1.11$

$$H = \left(1 + K_e + K_r + \frac{29n^2L}{r^{1.33}}\right)\frac{V^2}{2g} = (1.65 + .05)\frac{V^2}{2g}$$

$$H = (1.7)\frac{V^2}{2g}$$

$$V \approx \sqrt{38\,H}$$

O'BRIEN & GERE ENGINEERS

SUBJECT	SHEET	BY	DATE	JOB NO
CRANBERRY LAKE DAM	5	REL	6/20/78	

Checked DBC

STAGE – DISCHARGE (Cont)

– Assume Stoplog gates and log sluice to be closed and ineffective in passing flows

– Spillway Capacity

Spillway Crest elev = 1490.0'
Crest length = 110.0'
Weir Coeff = 3.0

$$Q = CLH^{3/2} = 330H^{3/2}$$

--- Above Elevation 1493.5 assume an additional Overflow Length ≈ 150 feet C = 2.6

$$Q = CLH^{3/2} = 494\,H^{3/2} \quad \text{use} \quad 500\,H^{3/2}$$

O'BRIEN & GERE ENGINEERS

SUBJECT	SHEET	BY	DATE	JOB NO
CRANBERRY LAKE DAM	6	KEL	6/29/78	

Checked DBC

STAGE - DISCHARGE RATING

Elev	(ft) HGATES	(ft) HSPILLWAY	(ft) Hoverflow	(cfs) QG	(cfs) Qs	(cfs) Qo	(cfs) Q Total
1490	Assumed closed @ start of PMF	0	0	0	0	0	Say 0
1492	14	2	0	923	933	0	1856
1494	16	4	.5	986	2640	177	3803
1496	18	6	2.5	1046	4850	1976	7872
1498	20	8	4.5	1102	7467	4773	13342
1500	22	10	6.5	1157	10436	8286	19879
1502	24	12	8.5	1208	13718	12351	27317

JUSTIN & COURTNEY, INC.
Division of O'Brien & Gere Engineers, Inc.
PHILADELPHIA, PA

SHEET NO. 6A OF _____

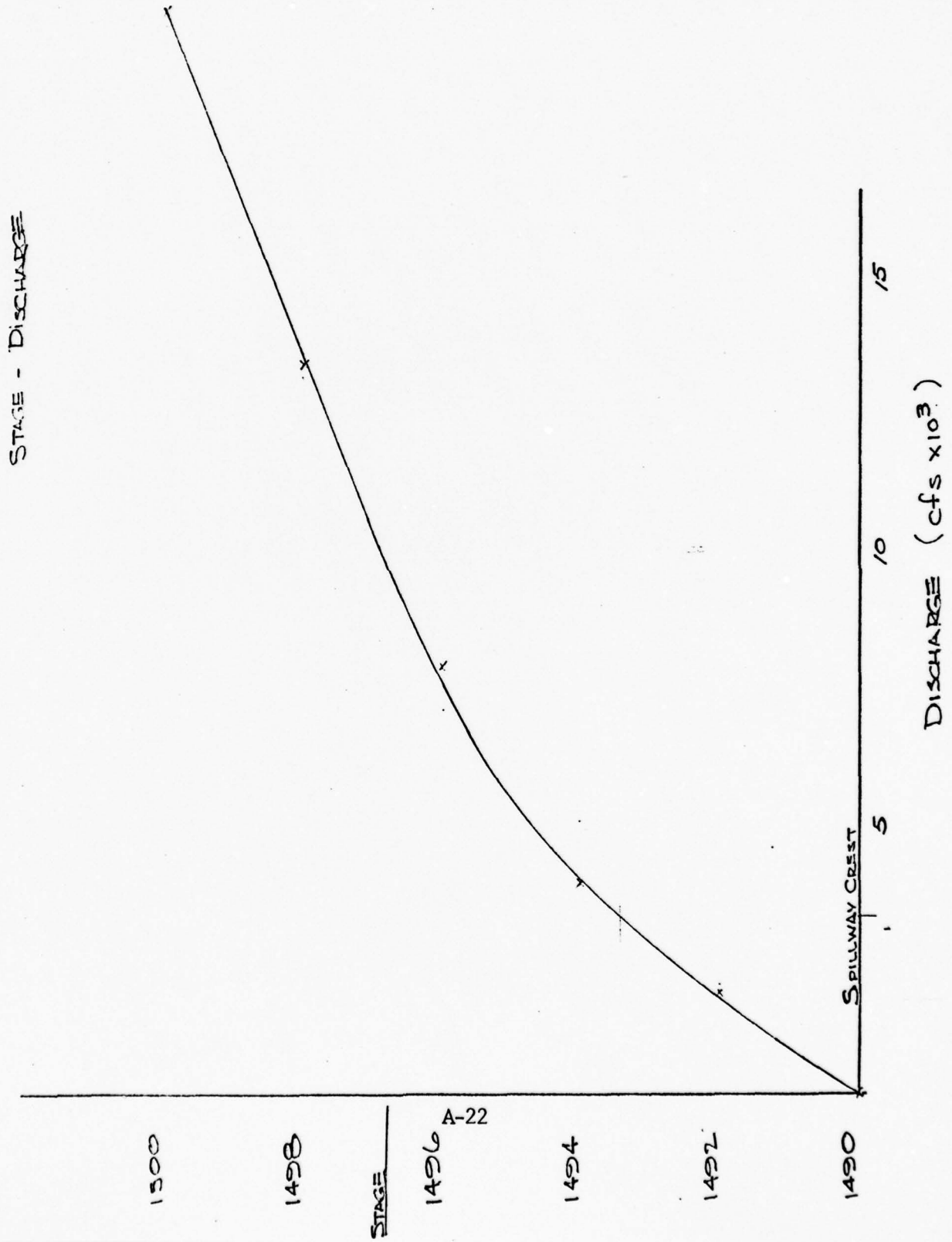
DATE 6/23/78

NAME OF CLIENT NYSDEC

COMP. BY REH

PROJECT CRANBERRY LAKE DAM

CHECKED BY DBC



O'BRIEN & GERE ENGINEERS

SUBJECT	SHEET	BY	DATE	JOB NO
CRANBERRY LAKE DAM	7	R.E.L	6/29/78	

Checked DBC

STAGE - STORAGE

Surface area at spillway crest = 7104 Ac (from USGS sheet 1:625,000 Scale)

Storage at spillway crest = 57400 Ac-Ft (from NYSDEC)

Approx lake depth = $\frac{7104+0}{2}$ $d = 57400$ $d = 16.2'$

Assume Area varies w/ depth $7104/16.2 = 438.5$ Ac/Ft

Above Spillway Crest - @ 1490 Area = 7104 Ac, @ 1500 Area = 11264 Ac

$\therefore A = 416\,d$, Storage $= 208\,d^2 + 7104d$

Stage	Area (Ac)	INC Storage (Ac-Ft)	Accum Stor (Ac-Ft)	
1473.8	0	0	0	
1478.0	1841.8	3867.8	3867.8	
1482.0	3595.8	10875.2	14743.0	
1486.0	5349.9	17891.4	32634.4	
1490.0	7104.0	24907.8	57542.2	Acc Stor
1492	7936.0		72582	15040
1494	8768.0		89286	31744
1496	9600.0		107654	50112
1498	10432.0		127686	70144
1500	11264.0		149382	91840
1502	12096.0		172742	115200

Above Spillway Elev.

Planimeter check w/ USGS 1:625,000 series - Lake Area @ El 1500

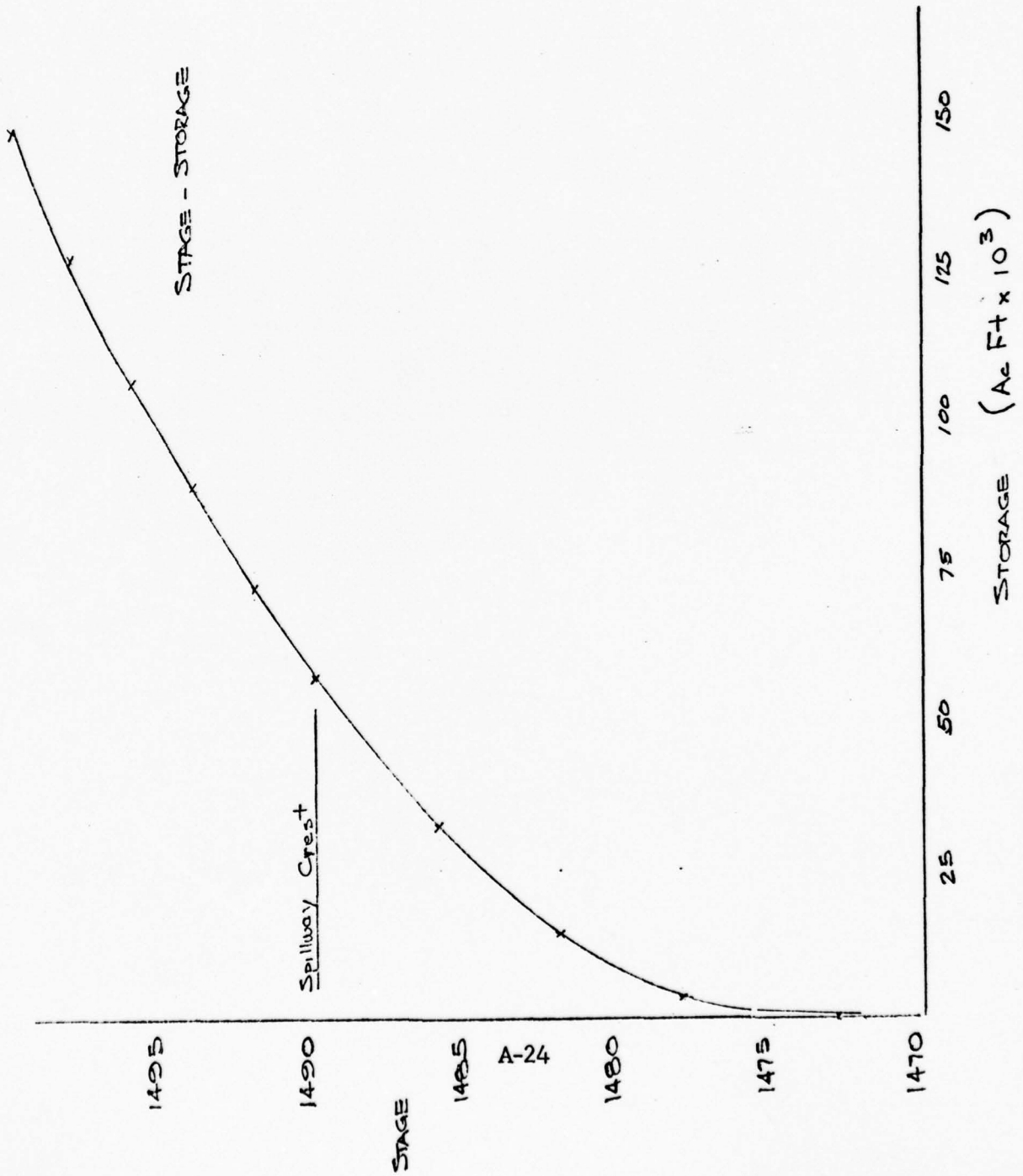
$= 1.1(16) \times \frac{5280^2}{43560} = 11{,}264$ Ac

JUSTIN & COURTNEY, INC.
Division of O'Brien & Gere Engineers, Inc.
PHILADELPHIA, PA

SHEET NO. 7A OF _____
DATE 6/29/78
COMP. BY REH
CHECKED BY DBC

NAME OF CLIENT NYSDEC.

PROJECT CRANBERRY LAKE DAM



JUSTIN & COURTNEY, INC.
Division of O'Brien & Gere Engineers, Inc.
PHILADELPHIA, PA

SHEET NO. _____ OF _____

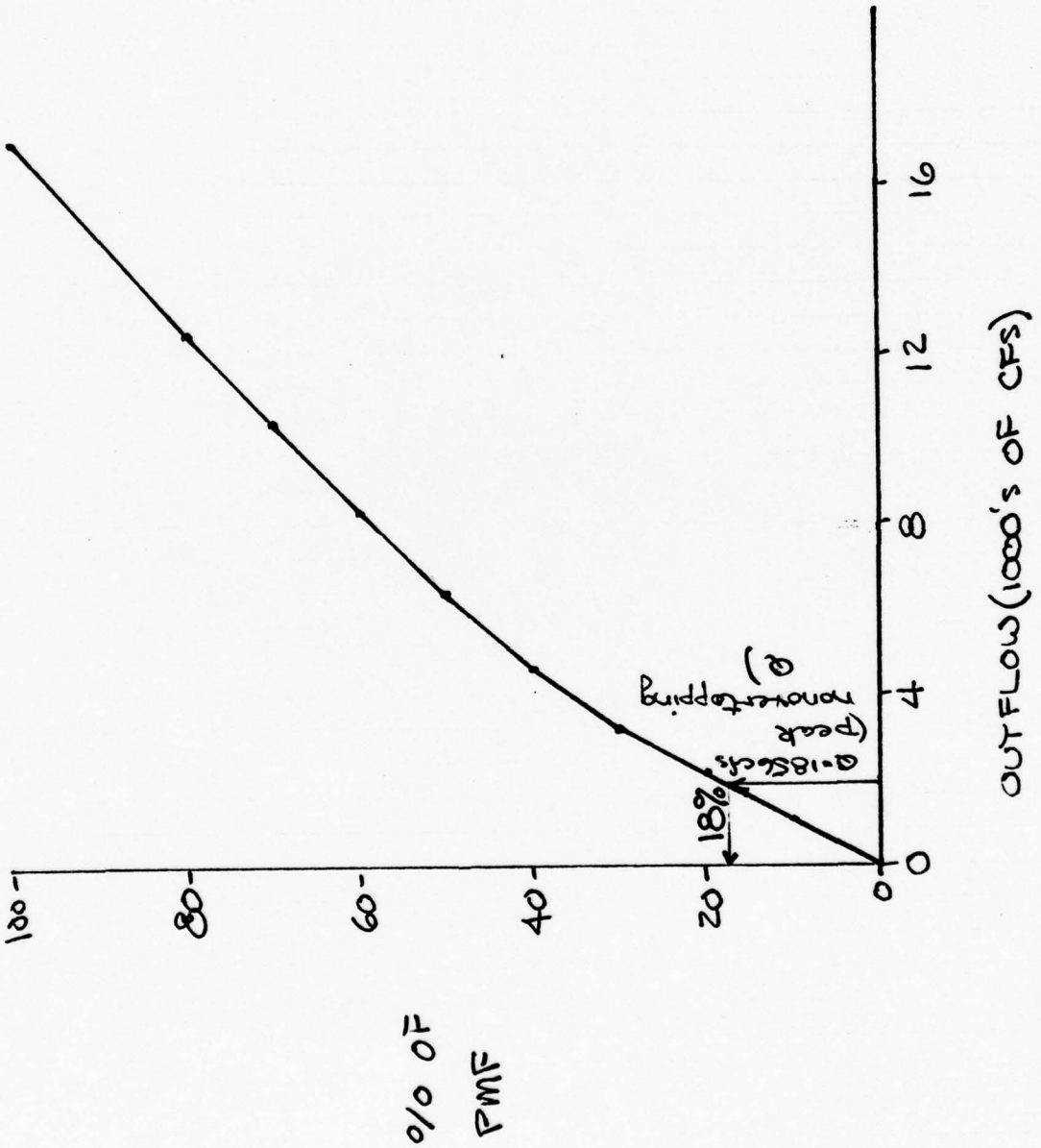
DATE 8/27/78

NAME OF CLIENT NYSDEC

COMP. BY DBC

PROJECT Cranberry Lake

CHECKED BY REH



O'BRIEN & GERE ENGINEERS

SUBJECT	SHEET	BY	DATE	JOB NO
CRANBERRY LAKE DAM	8	REH	6/29/78	

Checked DBC

DRAWDOWN ANALYSIS - Assume - 2 - 5'x 4' gates fully open

- Water surface at spillway crest

Elev	Head	Vel (fps)	Area (sqft)	Q (cfs)
1490	13.8	22.9	40	916
1486	9.8	19.3		772
1482	5.8	14.8		592
1478	1.8	8.2		331
1473.8	0	0		0

Elev	to	Elev	Storage (CF)	Avg Dis (cfs)	TIME (Hrs)
1490	-	1486	1085×10^6	844	357
1486	-	1482	779×10^6	682	317
1482	-	1478	642×10^6	462	386
1478	-	1473.8	168×10^6	166	211

Time required ≈ 53 days

The results give a minimum time for drawdown using only the two gated openings for discharge. No consideration has been given to downstream constraints which might restrict discharge velocities and flows.

****
HEC-1 VERSION DATED JAN 1973
UPDATED AUG 74
CHANGE NO. 01
****

PMF ROUTING
CRANBERRY LAKE DAM
O'BRIEN + GERE - JUSTIN + COURTNEY DIV

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IHMN	METRC	IPLT	IPRT	NSTAN
48	2	0	1	0	0	0	0	2	0

JOPER: 5 NWT: 0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 9 LRTIO= 1
RTIOS= .10 .20 .30 .40 .50 .60 .70 .80 1.00

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SUB-AREA RUNOFF COMPUTATION

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
1	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IJHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	1	144.00	0.00	0.00	0.00	0.000	0	0	0

PRECIP DATA

MP	STORM	DAJ	DAK
6	0.00	0.00	0.00

PRECIP PATTERN
.30 .50 2.00 8.60 2.70 .80

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.00	0.00	1.00	0.00	0.00	1.00	0.00	.10	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 10.00 CP= .63 NTA= 0

RECESSION DATA
STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 5.81 AND R= 4.44 INTERVALS

UNIT HYDROGRAPH 27 END-OF-PERIOD ORDINATES, LAG= 9.94 HOURS, CP= .62 VOL= 1.00

475.	1722.	3365.	4887.	5788.	5771.	4947.	3946.	3147.	2509.
2001.	1596.	1273.	1015.	810.	646.	515.	411.	327.	261.
208.	166.	132.	106.	84.	67.	54.			

END-OF-PERIOD FLOW

	TIME	RAIN	EXCS	COMP Q
1	2 0	.80	.60	285.
		.80	.60	1319.

1	14	0	0.00	0.00	67346.
1	16	0	0.00	0.00	78577.
1	18	0	0.00	0.00	79037.
1	20	0	0.00	0.00	69953.
1	22	0	0.00	0.00	57344.
2	0	0	0.00	0.00	45939.
2	2	0	0.00	0.00	36636.
2	4	0	0.00	0.00	29218.
2	6	0	0.00	0.00	23301.
2	8	0	0.00	0.00	18583.
2	10	0	0.00	0.00	14820.
2	12	0	0.00	0.00	11819.
2	14	0	0.00	0.00	9425.
2	16	0	0.00	0.00	7517.
2	18	0	0.00	0.00	5995.
2	20	0	0.00	0.00	4781.
2	22	0	0.00	0.00	3813.
3	0	0	0.00	0.00	3041.
3	2	0	0.00	0.00	2425.
3	4	0	0.00	0.00	1934.
3	6	0	0.00	0.00	1542.
3	8	0	0.00	0.00	1204.
3	10	0	0.00	0.00	935.
3	12	0	0.00	0.00	669.
3	14	0	0.00	0.00	174.
3	16	0	0.00	0.00	32.
3	18	0	0.00	0.00	0.
3	20	0	0.00	0.00	0.
3	22	0	0.00	0.00	0.
4	0	0	0.00	0.00	0.
4	2	0	0.00	0.00	0.
4	4	0	0.00	0.00	0.
4	6	0	0.00	0.00	0.
4	8	0	0.00	0.00	0.
4	10	0	0.00	0.00	0.
4	12	0	0.00	0.00	0.
4	14	0	0.00	0.00	0.
4	16	0	0.00	0.00	0.
4	18	0	0.00	0.00	0.
4	20	0	0.00	0.00	0.
4	22	0	0.00	0.00	0.
5	0	0	0.00	0.00	0.
		SUM	15.70	14.50	670323.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	79037.	75856.	48554.	18620.	670320.
INCHES		4.90	12.55	14.43	14.43
AC-FT		37634.	96354.	110854.	110854.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1

29.	132.	391.	1204.	2812.	4859.	6735.	7858.	7904.	6995.
5734.	4594.	3664.	2922.	2330.	1858.	1482.	1182.	943.	752.
599.	478.	381.	304.	242.	193.	154.	120.	93.	67.
17.	3.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.		

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	7904.	7586.	4855.	1862.	67032.
INCHES		.49	1.25	1.44	1.44
AC-FT		3763.	9635.	11085.	11085.

35. 6. 0. 0. 0. 0. 0. 0. 0. 0.
0. 0. 0. 0. 0. 0. 0. 0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	15807.	15171.	9711.	3724.	134064.
INCHES		.98	2.51	2.89	2.89
AC-FT		7527.	19271.	22171.	22171.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 3

86. 396. 1172. 3613. 8436. 14577. 20204. 23573. 23711. 20986.
17203. 13782. 10991. 8765. 6990. 5575. 4446. 3546. 2828. 2255.
1798. 1434. 1144. 912. 727. 580. 463. 369. 280. 201.
52. 10. 0. 0. 0. 0. 0. 0. 0. 0.
0. 0. 0. 0. 0. 0. 0. 0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	23711.	22757.	14566.	5586.	201096.
INCHES		1.47	3.76	4.33	4.33
AC-FT		11290.	28906.	33256.	33256.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 4

114. 527. 1563. 4817. 11247. 19436. 26938. 31431. 31615. 27981.
22937. 18376. 14655. 11687. 9320. 7433. 5928. 4727. 3770. 3007.
2398. 1912. 1525. 1216. 970. 774. 617. 492. 374. 267.
70. 13. 0. 0. 0. 0. 0. 0. 0. 0.
0. 0. 0. 0. 0. 0. 0. 0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	31615.	30342.	19421.	7449.	268128.
INCHES		1.96	5.02	5.77	5.77
AC-FT		15054.	38542.	44342.	44342.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 5

143. 659. 1954. 6021. 14059. 24295. 33673. 39289. 39518. 34977.
28672. 22969. 18318. 14609. 11651. 9291. 7410. 5909. 4713. 3758.
2997. 2390. 1906. 1520. 1212. 967. 771. 602. 467. 334.
87. 16. 0. 0. 0. 0. 0. 0. 0. 0.
0. 0. 0. 0. 0. 0. 0. 0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	39518.	37928.	24277.	9310.	335160.
INCHES		2.45	6.27	7.22	7.22
AC-FT		18817.	48177.	55427.	55427.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 6

171. 791. 2345. 7225. 16871. 29154. 40408. 47146. 47422. 41972.
34406. 27563. 21982. 17531. 13981. 11150. 8892. 7091. 5655. 4510.
3597. 2868. 2288. 1824. 1455. 1160. 925. 723. 561. 401.
105. 19. 0. 0. 0. 0. 0. 0. 0. 0.
0. 0. 0. 0. 0. 0. 0. 0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	47422.	45513.	29132.	11172.	402192.
INCHES		2.94	7.53	8.66	8.66
AC-FT		22580.	57813.	66512.	66512.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 7

200. 923. 2735. 8430. 19683. 34013. 47142. 55004. 55326. 48967.
40141. 32157. 25645. 20452. 16311. 13008. 10374. 8273. 6598. 5262.
4196. 3347. 2669. 2128. 1697. 1354. 1080. 861. 654. 468.
122. 23. 0. 0. 0. 0. 0. 0. 0. 0.
0. 0. 0. 0. 0. 0. 0. 0.

AC-FT			26344.	67448.	77598.		77598.		

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 8

228.	1055.	3126.	9634.	22495.	38872.	53877.	62862.	63230.	55963.
45875.	36751.	29309.	23374.	18641.	14866.	11856.	9455.	7540.	6013.
4796.	3825.	3050.	2432.	1940.	1547.	1234.	963.	748.	535.
139.	26.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.		

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	63230.	60685.	38843.	14896.	536256.
INCHES		3.92	10.04	11.55	11.55
AC-FT		30107.	77083.	88683.	88683.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 9

285.	1319.	3908.	12042.	28119.	48590.	67346.	78577.	79037.	69953.
57344.	45939.	36636.	29218.	23301.	18583.	14820.	11819.	9425.	7517.
5995.	4781.	3813.	3041.	2425.	1934.	1542.	1204.	935.	669.
174.	32.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.		

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	79037.	75856.	48554.	18620.	670320.
INCHES		4.90	12.55	14.43	14.43
AC-FT		37634.	96351.	110854.	110854.

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HYDROGRAPH ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
2	1	0	0	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.000	0.00	1	1

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
1	0	0	0.000	0.000	0.000	-1.

STORAGE=	0.	15040.	31744.	50112.	70144.	91840.	115200.	140224.	0.	0.
OUTFLOW=	0.	1866.	3803.	7872.	13342.	19879.	27317.	35555.	0.	0.

STATION 2, PLAN 1, RTIO 1

29.	30.	34.	50.	89.	165.	279.	420.	571.	710.
824.	912.	977.	1023.	1056.	1077.	1089.	1094.	1093.	1088.
1080.	1069.	1056.	1041.	1026.	1010.	993.	975.	958.	940.
922.	904.	885.	868.	850.	833.	816.	800.	783.	768.
752.	737.	722.	707.	693.	679.	665.	652.		

STOR

231.	233.	277.	402.	723.	1336.	2257.	3405.	4626.	5752.
6677.	7387.	7913.	8292.	8555.	8724.	8822.	8861.	8856.	8816.
8749.	8660.	8556.	8439.	8313.	8181.	8044.	7904.	7762.	7619.
7472.	7322.	7175.	7030.	6888.	6749.	6613.	6479.	6348.	6220.
6095.	5972.	5851.	5733.	5617.	5504.	5393.	5284.		

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1094.	1092.	1066.	920.	36789.
INCHES		.07	.28	.71	.79
AC-FT		542.	2115.	5478.	6084.

1848.	1811.	1774.	1738.	1703.	1669.	1635.	1602.	1570.	1538.
1507.	1477.	1447.	1418.	1389.	1361.	1333.	1307.		

STOR

462.	479.	555.	804.	1445.	2671.	4514.	6811.	9252.	11503.
13354.	14774.	15827.	16586.	17113.	17455.	17652.	17734.	17727.	17649.
17517.	17342.	17135.	16903.	16653.	16390.	16117.	15838.	15554.	15267.
14972.	14673.	14378.	14087.	13803.	13524.	13251.	12983.	12721.	12464.
12213.	11966.	11725.	11488.	11256.	11029.	10806.	10588.		

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2170.	2167.	2118.	1837.	73456.
INCHES		.14	.55	1.42	1.58
AC-FT		1075.	4203.	10935.	12148.

STATION 2, PLAN 1, RTIO 3

86.	89.	103.	149.	268.	494.	836.	1261.	1713.	2114.
2438.	2687.	2872.	3006.	3099.	3160.	3195.	3210.	3210.	3197.
3175.	3145.	3110.	3070.	3027.	2982.	2935.	2887.	2838.	2788.
2737.	2686.	2635.	2584.	2535.	2487.	2439.	2393.	2347.	2302.
2259.	2215.	2173.	2131.	2091.	2051.	2012.	1973.		

STOR

693.	718.	832.	1207.	2168.	4007.	6771.	10216.	13878.	17256.
20036.	22173.	23761.	24908.	25705.	26226.	26529.	26660.	26656.	26547.
26355.	26100.	25796.	25455.	25087.	24699.	24296.	23883.	23463.	23037.
22602.	22159.	21720.	21284.	20865.	20450.	20043.	19644.	19252.	18868.
18491.	18121.	17759.	17403.	17054.	16712.	16376.	16047.		

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3210.	3206.	3134.	2727.	109192.
INCHES		.21	.81	2.11	2.35
AC-FT		1591.	6219.	16233.	18058.

STATION 2, PLAN 1, RTIO 4

114.	118.	137.	199.	357.	659.	1114.	1681.	2260.	2785.
3218.	3551.	3798.	4131.	4360.	4505.	4583.	4610.	4597.	4553.
4487.	4403.	4306.	4201.	4089.	3973.	3856.	3768.	3704.	3639.
3573.	3506.	3439.	3373.	3309.	3246.	3184.	3123.	3064.	3005.
2948.	2892.	2836.	2782.	2729.	2677.	2626.	2576.		

STOR

924.	958.	1109.	1609.	2891.	5343.	9029.	13621.	18506.	23014.
26726.	29581.	31704.	33225.	34260.	34912.	35255.	35386.	35327.	35131.
34831.	34452.	34016.	33540.	33035.	32513.	31981.	31442.	30895.	30341.
29773.	29195.	28622.	28059.	27507.	26965.	26433.	25912.	25401.	24899.
24407.	23925.	23451.	22987.	22531.	22085.	21646.	21216.		

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4610.	4596.	4402.	3670.	146646.
INCHES		.30	1.14	2.85	3.16
AC-FT		2280.	8736.	21851.	24252.

STATION 2, PLAN 1, RTIO 5

143.	148.	171.	248.	446.	824.	1393.	2088.	2800.	3457.
4171.	4950.	5514.	5908.	6167.	6322.	6395.	6405.	6365.	6289.
6184.	6059.	5918.	5767.	5609.	5446.	5281.	5116.	4952.	4788.
4623.	4457.	4299.	4144.	3995.	3852.	3755.	3684.	3613.	3544.
3477.	3410.	3345.	3282.	3219.	3157.	3097.	3038.		

STOR

1155.	1197.	1387.	2011.	3613.	5678.	11286.	17928.	23137.	28777.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	6405.	6388.	6116.	4827.	191316.
INCHES		.41	1.58	3.74	4.12
AC-FT		3169.	12136.	28736.	31639.

STATION 2, PLAN 1, RTIO 6

171.	177.	205.	298.	535.	989.	1671.	2485.	3340.	4417.
5631.	6543.	7199.	7650.	7957.	8161.	8243.	8232.	8150.	8014.
7846.	7680.	7496.	7301.	7097.	6889.	6679.	6468.	6259.	6051.
5842.	5635.	5432.	5237.	5049.	4867.	4692.	4523.	4361.	4204.
4053.	3907.	3784.	3711.	3641.	3571.	3503.	3436.		

STOR

1386.	1437.	1664.	2413.	4336.	8014.	13543.	20435.	27769.	34516.
39998.	44113.	47072.	49111.	50425.	51170.	51470.	51430.	51129.	50634.
49993.	49244.	44416.	47533.	46614.	45674.	44725.	43775.	42829.	41891.
40950.	40012.	39099.	38217.	37367.	36548.	35758.	34996.	34262.	33554.
32872.	32214.	31578.	30959.	30351.	29755.	29170.	28597.		

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	8243.	8212.	7827.	6081.	239283.
INCHES		.53	2.02	4.71	5.15
AC-FT		4074.	15533.	36201.	39571.

STATION 2, PLAN 1, RTIO 7

200.	207.	240.	347.	624.	1154.	1945.	2882.	3948.	5681.
7079.	8181.	9096.	9712.	10094.	10296.	10357.	10312.	10185.	9997.
9764.	9500.	9213.	8913.	8604.	8291.	7979.	7707.	7457.	7209.
6960.	6712.	6471.	6239.	6014.	5798.	5590.	5389.	5195.	5008.
4828.	4654.	4487.	4326.	4170.	4020.	3876.	3768.		

STOR

1617.	1676.	1941.	2816.	5059.	9349.	15800.	23843.	32397.	40221.
46530.	51244.	54594.	55849.	58250.	58988.	59214.	59047.	58582.	57894.
57042.	56074.	55024.	53923.	52791.	51647.	50504.	49366.	48237.	47118.
45995.	44877.	43790.	42739.	41727.	40750.	39839.	38902.	38027.	37184.
36371.	35587.	34832.	34104.	33401.	32725.	32072.	31440.		

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	10357.	10322.	9787.	7430.	290676.
INCHES		.67	2.53	5.76	6.26
AC-FT		5121.	19421.	44232.	48070.

STATION 2, PLAN 1, RTIO 8

228.	236.	274.	397.	713.	1319.	2208.	3280.	4966.	6930.
8657.	10099.	11111.	11783.	12190.	12392.	12434.	12356.	12186.	11947.
11658.	11334.	10985.	10621.	10249.	9874.	9499.	9128.	8763.	8405.
8049.	7730.	7452.	7184.	6926.	6677.	6437.	6205.	5982.	5767.
5560.	5360.	5167.	4981.	4802.	4629.	4463.	4302.		

STOR

1848.	1915.	2219.	3218.	5781.	10685.	18059.	27253.	36992.	45860.
52988.	58267.	61973.	64435.	65926.	66664.	66820.	66533.	65909.	65035.
63977.	62790.	61513.	60181.	58817.	57442.	56071.	54713.	53376.	52063.
50759.	49469.	48216.	47007.	45841.	44716.	43633.	42588.	41581.	40610.
39674.	38771.	37901.	37062.	36254.	35474.	34723.	33999.		

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	12434.	12394.	11750.	8807.	343895.
INCHES		.80	3.04	6.83	7.41
AC-FT		6149.	23317.	52431.	56871.

5534.	15041.	14519.	13980.	13434.	12928.	12435.	11946.	11466.	10996.
10529.	10069.	9625.	9200.	8794.	8406.	8035.	7716.	7438.	7171.
6913.	6664.	6425.	6194.	5971.	5756.	5549.	5350.		

STOR

2319.	2394.	2773.	4022.	7227.	13356.	22576.	34053.	46144.	57072.
65781.	72159.	76568.	79415.	81047.	81743.	81721.	81155.	80181.	78908.
77420.	75784.	74051.	72262.	70448.	68630.	66821.	65033.	63275.	61551.
59842.	58156.	56532.	54976.	53489.	52067.	50708.	49407.	48154.	46947.
45783.	44661.	43579.	42536.	41531.	40562.	39627.	38727.		

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	16837.	16776.	15816.	11640.	452673.
INCHES		1.08	4.09	9.02	9.75
AC-FT		8323.	31387.	69298.	74861.

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PEAK FLOW SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

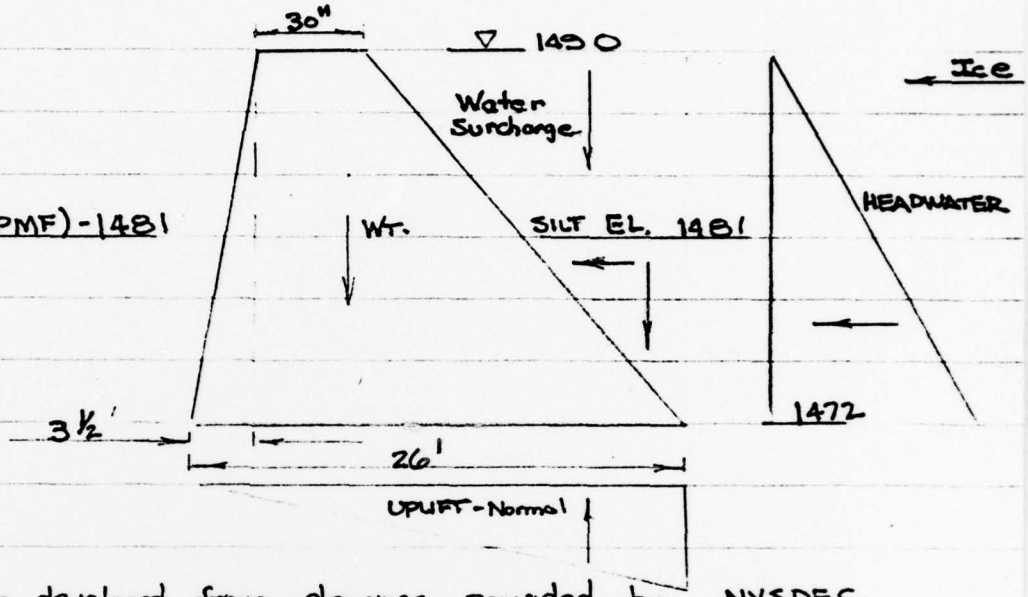
OPERATION	STATION	PLAN	RATIOS APPLIED TO FLOWS .10	.20	.30	.40	.50	.60	.70	.80	1.00
HYDROGRAPH AT	1	1	7904.	15807.	23711.	31615.	39518.	47422.	55326.	63230.	79037.
		2	0.	0.	0.	0.	0.	0.	0.	0.	0.
ROUTED TO	2	1	1094.	2170.	3210.	4610.	6405.	8243.	10357.	12434.	16837.
		2	0.	0.	0.	0.	0.	0.	0.	0.	0.

STABILITY ANALYSES

O'BRIEN&GERE ENGINEERS

SUBJECT	SHEET	BY	DATE	JOB NO
CANADERAGA LAKE DAM	1	REL	7/3/78	NYSDEC

SPILLWAY SECTION



Section developed from drawings provided by NYSDEC and OR-CRC and from visual observations

Assumptions: - Unit weight of concrete = 144 pcf
- Unit weight of silt (wet) = 86 pcf
- Internal ∠ of friction for silt = 30° Assumed at dam location
- Ice pressure = 5 ksf (2 foot thickness)
- ∠ of friction - concrete/foundation = 30°
- Shear resistance - concrete/rock foundation = 100 psi
- Seismic coeff. of acceleration = .1 g
- negative pressures resulting from separation of lower nappe are beyond the scope of this phase of study and are not included.

O'BRIEN & GERE ENGINEERS

SUBJECT	SHEET	BY	DATE	JOB NO
CRANBERRY LAKE DAM	2	RFH	5/5/78	

SPILLWAY STABILITY ANALYSES - SUMMARY

LOADING CONDITION	SF - OVERTURNING	SF - SLIDING	BEARING PRESSURES
NORMAL POOL	2.05	1.84	17.8 psi 1.4 psi
PMF	1.90	1.73	20.1 psi 4.6 psi
EARTHQUAKE	1.86	1.29	19.8 psi - .6 psi
ICE LOADING	1.35	1.04	27.2 psi - 8.8 psi

Negative bearing pressures indicate tension developed in the upstream face.

7/12/78

NATIONAL DAM INSPECTION PROGRAM CRANBERRY LAKE DAM
SPILLWAY SECTION - NORMAL POOL EL= 1490

BASE ELEVATION= 1472.00FT. TOP ELEVATION= 1490.00FT. BASE WIDTH= 26.00FT. DENSITY= 144.00PCF
HEADWATER ELEVATION= 1490.00FT. TAILWATER ELEVATION= 0.00FT. EARTHQUAKE ACCELERATION=***.000G (HORIZ)..000G (VERT)
SILT ELEVATION= 1481.00FT. SILT DENSITY(SUBMERGED)= 86.00PCF SILT PRESSURE COEFFICIENT(K)= .33
SHEAR STRESS= 100.00PSI SHEAR WIDTH= 26.00FT. FRICTION FACTOR= .58

LOADING	FORCE(KIPS)	ARM(FEET)	STABILIZING MOMENT	OVERTURNING MOMENT
WEIGHT OF DAM	36.94	10.01	369.69	
HEADWATER	10.11	5.99		60.59
UPLIFT	14.60	17.33		253.09
SILT	1.16	3.00		3.48
SILT SURCHARGE	3.40	23.00	78.20	
WATER SURCHARGE	10.10	20.00	202.00	
			649.88	317.17

NET HORIZONTAL FORCE= 11.27 KIPS
NET VERTICAL FORCE= 35.63 KIPS
NET MOMENT= 332.72KIP-FEET
X-BAR OF FOUNDATION REACTION= 9.28 FEET
ECCENTRICITY OF FOUNDATION REACTION FROM CENTER= 3.72 FEET
FOUNDATION REACTION PRESSURES*******TOE= 17.78 PSI*******HEEL= 1.37 PSI*******
OVERTURNING FACTOR OF SAFETY= 2.05
SLIDING FACTOR OF SAFETY= 1.84
DEVELOPED FRICTION FACTOR (NO SHEAR)= .31
SLIDING WITH SHEAR FACTOR OF SAFETY= 35.07(SHEAR ACROSS FULL BASE WIDTH)

****

NATIONAL DAM INSPECTION PROGRAM - CRANBERRY LAKE DAM
SPILLWAY SECTION--PMF

****

BASE ELEVATION= 1472.00FT. TOP ELEVATION= 1490.00FT. BASE WIDTH= 26.00FT. DENSITY= 144.00PCF
HEADWATER ELEVATION= 1499.00FT. TAILWATER ELEVATION= 1482.00FT. EARTHQUAKE ACCELERATION***.000G (HOR1Z)..000G (VERT)
SILT ELEVATION= 1481.00FT. SILT DENSITY(SUBMERGED)= 86.00PCF SILT PRESSURE COEFFICIENT(K)= .33
SHEAR STRESS= 100.00PSI SHEAR WIDTH= 26.00FT. FRICTION FACTOR= .58

****

LOADING	FORCE(KIPS)	ARM(FEET)	STABILIZING MOMENT	OVERTURNING MOMENT
WEIGHT OF DAM	36.94	10.01	369.68	
HEADWATER	20.22	7.50		151.63
TAILWATER	3.12	3.33	10.39	
UPLIFT	30.01	14.99		449.95
SILT	1.16	3.00		3.48
SILT SURCHARGE	3.40	23.00	78.20	
WATER SURCHARGE	22.46	17.67	396.87	
			*********	*********
			855.14	605.06

****

NET HORIZONTAL FORCE= 14.86 KIPS
NET VERTICAL FORCE= 29.38 KIPS
NET MOMENT= 250.08KIP--FEET
X-BAR OF FOUNDATION REACTION= 8.51 FEET
ECCENTRICITY OF FOUNDATION REACTION FROM CENTER= 4.49 FEET
**********FOUNDATION REACTION NOT IN CENTRAL THIRD OF BASE*****TENSION AT HEEL OF DAM*****
FOUNDATION REACTION PRESSURES*******TOE= 15.90 PSI********HEEL= -.28 PSI********
OVERTURNING FACTOR OF SAFETY= 1.41
SLIDING FACTOR OF SAFETY= 1.15
DEVELOPED FRICTION FACTOR (NO SHEAR)= .51
SLIDING WITH SHEAR FACTOR OF SAFETY= 26.35(SHEAR ACROSS FULL BASE WIDTH)
NUMBER OF STATIONS TO DESCRIBE DAM= 4

STATION	ELEVATION
.00	1472.00
3.50	1490.00
6.00	1490.00
26.00	1472.00

STOP 0

NATIONAL DAM INSPECTION PROGRAM CRANBERRY LAKE DAM
SPILLWAY SECTION - EARTHQUAKE

BASE ELEVATION= 1472.00FT. TOP ELEVATION= 1490.00FT. BASE WIDTH= 26.00FT. DENSITY= 144.00PCF
HEADWATER ELEVATION= 1490.00FT. TAILWATER ELEVATION= 0.00FT. EARTHQUAKE ACCELERATION***.100G (HORIZ),.000G (VERT)
SILT ELEVATION= 1481.00FT. SILT DENSITY(SUBMERGED)= 86.00PCF SILT PRESSURE COEFFICIENT(K)= .33
SHEAR STRESS= 100.00PSI SHEAR WIDTH= 26.00FT. FRICTION FACTOR= .98

LOADING	FORCE(KIPS)	ARM(FEET)	STABILIZING MOMENT	OVERTURNING MOMENT
WEIGHT OF DAM	36.94	10.01	369.68	
HEADWATER	10.11	5.99		60.59
UPLIFT	14.60	17.33		253.09
EARTHQUAKE INDUCED LOADINGS				
INERTIA-WATER	1.10	7.20		7.93
HORIZONTAL INERTIA-DAM	3.69	6.53		24.11
SILT	1.16	3.00		3.48
SILT SURCHARGE	3.40	23.00	78.20	
WATER SURCHARGE	10.10	20.00	202.00	
			*********	*********
			649.88	349.20

NET HORIZONTAL FORCE= 16.06 KIPS
NET VERTICAL FORCE= 35.83 KIPS
NET MOMENT= 300.68KIP-FEET
X-BAR OF FOUNDATION REACTION= 8.39 FEET
ECCENTRICITY OF FOUNDATION REACTION FROM CENTER= 4.61 FEET
**********FOUNDATION REACTION NOT IN CENTRAL THIRD OF BASE*****TENSION AT HEEL OF DAM*****
FOUNDATION REACTION PRESSURES*******TOE= 19.75 PSI*******HEEL= -.61 PSI*******
OVERTURNING FACTOR OF SAFETY= 1.86
SLIDING FACTOR OF SAFETY= 1.29
DEVELOPED FRICTION FACTOR (NO SHEAR)= .45
SLIDING WITH SHEAR FACTOR OF SAFETY= 24.60(SHEAR ACROSS FULL BASE WIDTH)

NATIONAL DAM INSPECTION PROGRAM CRANBERRY LAKE DAM
SPILLWAY SECTION - ICE LOADING

BASE ELEVATION= 1472.00FT. TOP ELEVATION= 1490.00FT. BASE WIDTH= 26.00FT. DENSITY= 144.00PCF
HEADWATER ELEVATION= 1487.00FT. TAILWATER ELEVATION= 0.00FT. EARTHQUAKE ACCELERATION***.000G (HORIZ)..000G (VERT)
SILT ELEVATION= 1481.00FT. SILT DENSITY(SUBMERGED)= 86.00PCF SILT PRESSURE COEFFICIENT(K)= .33
SHEAR STRESS= 100.00PSI SHEAR WIDTH= 26.00FT. FRICTION FACTOR= .58

LOADING	FORCE(KIPS)	ARM(FEET)	STABILIZING MOMENT	OVERTURNING MOMENT
WEIGHT OF DAM	36.94	10.01	369.68	
HEADWATER	7.02	5.00		35.06
UPLIFT	12.17	17.33		210.91
SILT	1.16	3.00		3.48
SILT SURCHARGE	3.40	23.00	78.20	
WATER SURCHARGE	7.00	21.00	147.00	
ICE LOADING	15.00	16.50		247.50
			*********	*********
			594.88	496.96

NET HORIZONTAL FORCE= 23.18 KIPS
NET VERTICAL FORCE= 35.17 KIPS
NET MOMENT= 97.93KIP-FEET
X-BAR OF FOUNDATION REACTION= 2.78 FEET
ECCENTRICITY OF FOUNDATION REACTION FROM CENTER= 10.22 FEET
**********FOUNDATION REACTION NOT IN CENTRAL THIRD OF BASE*****TENSION AT HEEL OF DAM*****
FOUNDATION REACTION PRESSURES*******TOE= 31.54 PSI*******HEEL=-12.75 PSI*******
OVERTURNING FACTOR OF SAFETY= 1.20
SLIDING FACTOR OF SAFETY= .88
DEVELOPED FRICTION FACTOR (NO SHEAR)= .66
SLIDING WITH SHEAR FACTOR OF SAFETY= 17.03(SHEAR ACROSS FULL BASE WIDTH)

NATIONAL DAM INSPECTION PROGRAM CRANBERRY LAKE DAM
SPILLWAY SECTION - ICE LOADING

BASE ELEVATION= 1472.00FT. TOP ELEVATION= 1490.00FT. BASE WIDTH= 26.00FT. DENSITY= 144.00PCF
HEADWATER ELEVATION= 1488.00FT. TAILWATER ELEVATION= 0.00FT. EARTHQUAKE ACCELERATION=.000G (HORIZ),.000G (VERT)
SILT ELEVATION= 1481.00FT. SILT DENSITY(SUBMERGED)= 86.00PCF SILT PRESSURE COEFFICIENT(K)= .33
SHEAR STRESS= 100.00PSI SHEAR WIDTH= 26.00FT. FRICTION FACTOR= .58

LOADING	FORCE(KIPS)	ARM(FEET)	STABILIZING MOMENT	OVERTURNING MOMENT
WEIGHT OF DAM	36.94	10.01	369.68	
HEADWATER	7.99	5.33		42.56
UPLIFT	12.98	17.33		224.97
SILT	1.16	3.00		3.48
SILT SURCHARGE	3.40	23.00	78.20	
WATER SURCHARGE	7.00	21.00	147.00	
ICE LOADING	10.00	17.00		170.00
			*********	*********
			594.88	441.01

NET HORIZONTAL FORCE= 19.15 KIPS
NET VERTICAL FORCE= 34.36 KIPS
NET MOMENT= 153.88KIP-FEET
X-BAR OF FOUNDATION REACTION= 4.48 FEET
ECCENTRICITY OF FOUNDATION REACTION FROM CENTER= 8.52 FEET
**********FOUNDATION REACTION NOT IN CENTRAL THIRD OF BASE*****TENSION AT HEEL OF DAM*****
FOUNDATION REACTION PRESSURES********TOE= 27.22 PSI********HEEL= -8.87 PSI********
OVERTURNING FACTOR OF SAFETY= 1.35
SLIDING FACTOR OF SAFETY= 1.04
DEVELOPED FRICTION FACTOR (NO SHEAR)= .56
SLIDING WITH SHEAR FACTOR OF SAFETY= 20.59(SHEAR ACROSS FULL BASE WIDTH)